SCIENTIFIC AMERICAN SUPPLEMENT No. 844

Copyright by Munn & Co., 1892.

Scientific American Supplement, Vol. XXXIII. No. 844. Scientific American, established 1845.

NEW YORK, MARCH 5, 1892.

Scientific American Supplement, $5 a year. Scientific American and Supplement, $7 a year.

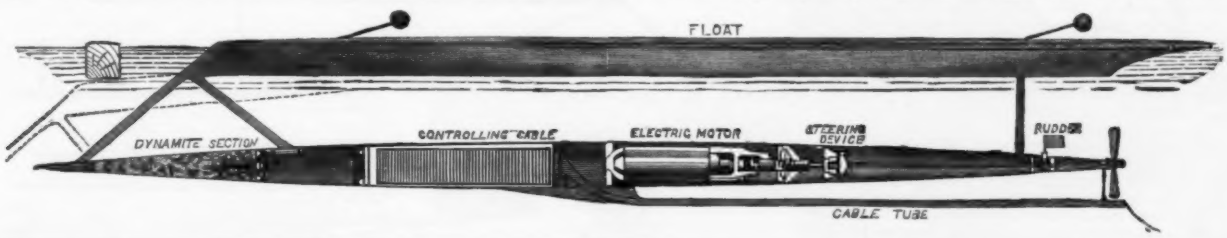
THE SIMS-EDISON TORPEDO.

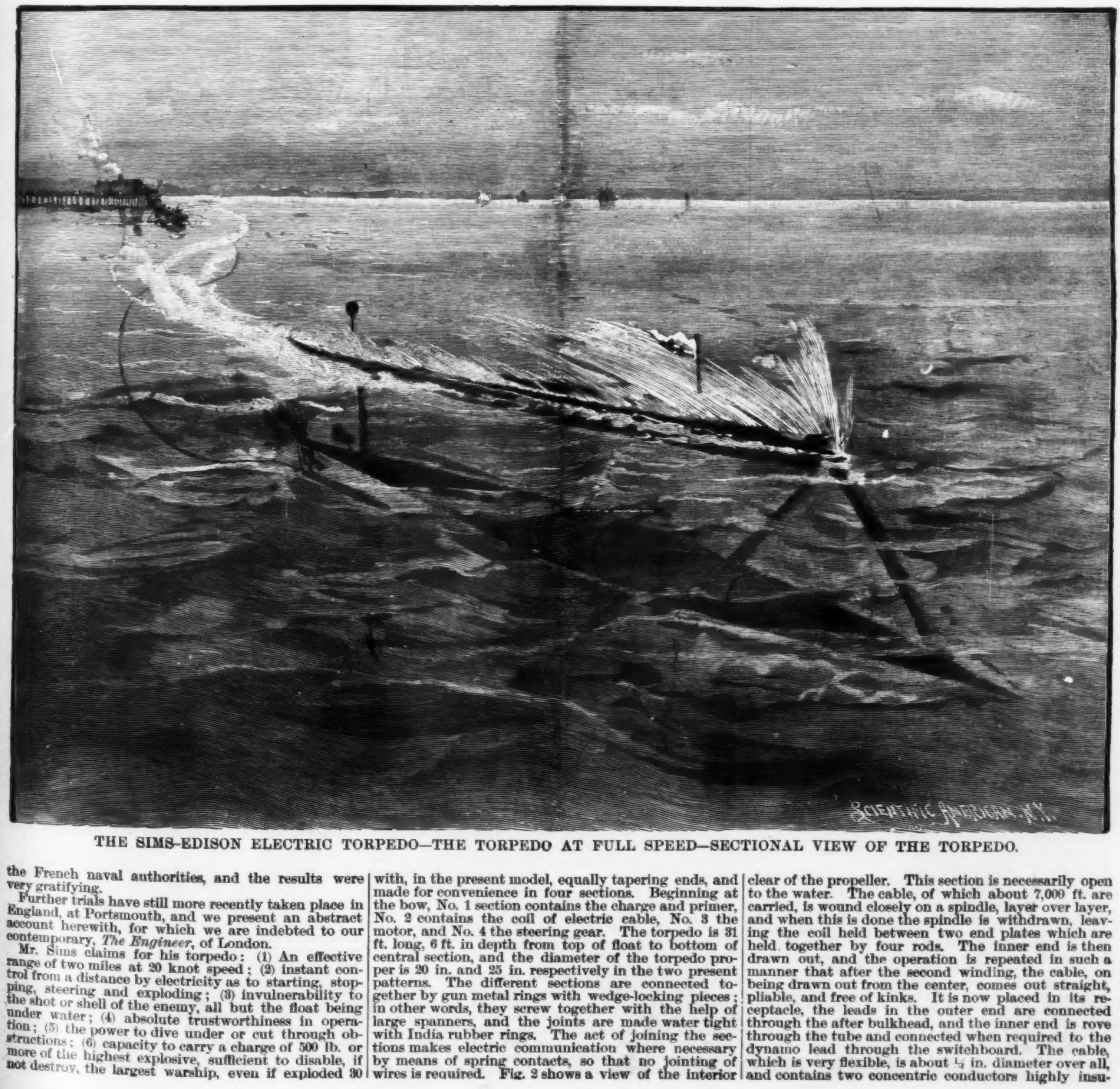
THIS interesting invention has been several times subjected to the severest tests on this side of the Atlantic, and is pronounced by our naval authorities to be a most effective and desirable aid in naval operations and harbor defense. The successes achieved here, and which have been heretofore fully described in the SCIENTIFIC AMERICAN, have led the patentees to efforts for the introduction of the invention abroad. Official trials were had in May last, near Havre, France, where the torpedo was worked in presence of the French naval authorities, and the results were very gratifying.

Further trials have still more recently taken place in England, at Portsmouth, and we present an abstract account herewith, for which we are indebted to our contemporary, *The Engineer*, of London.

Mr. Sims claims for his torpedo: (1) An effective range of two miles at 20 knot speed; (2) instant control from a distance by electricity as to starting, stopping, steering and exploding; (3) invulnerability to the shot or shell of the enemy, all but the float being under water; (4) absolute trustworthiness in operation; (5) the power to dive under or cut through obstructions; (6) capacity to carry a charge of 500 lb. or more of the highest explosive, sufficient to disable, if not destroy, the largest warship, even if exploded 30 ft. distant, which is about the limit of netting defense.

It will be interesting, then, to look into the construction of the torpedo, and see by what means these claims are to be made good. In Fig. 1 is shown the outward appearance of the complete torpedo, which consists of a copper float, shaped like a boat with very fine lines, with a curved deck, also of copper, on which are two vertical rods, surmounted by balls, to help to show the direction in which the torpedo is moving. Below this float is attached rigidly to it by steel stays the torpedo proper, which is a hollow copper spindle, with, in the present model, equally tapering ends, and made for convenience in four sections. Beginning at the bow, No. 1 section contains the charge and primer, No. 2 contains the coil of electric cable, No. 3 the motor, and No. 4 the steering gear. The torpedo is 31 ft. long, 6 ft. in depth from top of float to bottom of central section, and the diameter of the torpedo proper is 20 in. and 25 in. respectively in the two present patterns. The different sections are connected together by gun metal rings with wedge-locking pieces; in other words, they screw together with the help of large spanners, and the joints are made water tight with India rubber rings. The act of joining the sections makes electric communication where necessary by means of spring contacts, so that no jointing of wires is required. Fig. 2 shows a view of the interior of the torpedo. In No. 1 section is seen the charge, occupying the space from the nose as far as a supplementary bulkhead, through which the primer case is screwed into the center of the charge. At this bulkhead there is a joint, which is, however, seldom broken. The charge carried varies, but may be taken as about 500 lb. of gun cotton or other explosive, which is fired by means of an electric detonator, and not by percussion. No. 2 section is fitted with a lid which takes right off, so as to allow of putting in the coil of cable, and a tube comes away from it under the torpedo, through which the cable is carried away clear of the propeller. This section is necessarily open to the water. The cable, of which about 7,000 ft. are carried, is wound closely on a spindle, layer over layer, and when this is done the spindle is withdrawn, leaving the coil held between two end plates which are held together by four rods. The inner end is then drawn out, and the operation is repeated in such a manner that after the second winding, the cable, on being drawn out from the center, comes out straight, pliable, and free of kinks. It is now placed in its receptacle, the leads in the outer end are connected through the after bulkhead, and the inner end is rove through the tube and connected when required to the dynamo lead through the switchboard. The cable, which is very flexible, is about ¼ in. diameter over all, and contains two concentric conductors highly insu-





THE SIMS-EDISON ELECTRIC TORPEDO—THE TORPEDO AT FULL SPEED—SECTIONAL VIEW OF THE TORPEDO.

lated. The outer conductor carries the dynamo current for working the motor, and the inner carries current from a secondary battery, for operating relays in connection with the steering gear.

The after part of section 2 is bulkheaded off to form a watertight compartment, which contains a relay for sending the motor current through to the charge. Section 3 contains a two-pole series-wound motor of Edison make, which runs at about 1,600 revolutions per minute, and with a current of 25 amperes at 1,150 volts develops about 33 horse power. At the after end the shafting is geared down so as to give about 800 revolutions for the propeller. No. 4 section contains the shaft, which turns in metaline bearings, so that no oil is required in any part of the torpedo. A simple clutch connects this shaft with that in section 3, but they are insulated from one another by vulcanized fiber. This section also contains the steering mechanism, which consists of two electro-magnets for working the rudder one way or the other, and a relay for sending the main current from the motor to either of these electro-magnets on its road to the frame. On the top is carried the rudder, which, when not drawn over either way, is kept straight by the motion of the torpedo through the water. On the end of the shaft is keyed a gun metal right handed propeller 30 in. diameter, which for ship use will be fitted with a guard to prevent fouling the cable after launching. The sloping stay at the bow is made perfectly sharp so as to cut through obstructions, but failing to do this, the torpedo dives under, and when clear comes again to its former level. The vertical rods on the float are so constructed as to hinge back in such a case, and to spring up again when clear. The total weight of the torpedo ready for service may be taken as 1½ tons, and the floating power is all in the float, which for service is filled with cotton, so that if riddled with shot it would still leave a sufficient margin of buoyancy.

The current for operating the motor is produced by a continuous current dynamo, shunt wound, capable of producing a current of 32 amperes at 1,200 to 1,300 volts. The current for working the steering relay is taken from a small box of secondary cells, giving current at 50 volts. The torpedo is worked by sending the dynamo current in a given direction, and can be switched on or off as desired, and also reduced or increased, by means of a set of resistances in the shunt. When the charge is to be fired, the main current is reversed by means of a suitable switch. This acts on the relay in the after end of section 2 and the current goes through to the charge. Just before switching over, the current is reduced by means of the resistances. For steering, the current from the second battery is sent through in one direction or the other by means of a suitable switch, and so acts on the relay as to send the main current to either of the two electro-magnets which work the rudder.

The return for both currents is by water through the frame of the torpedo. To avoid a chance of premature explosion, a safety plug is attached to the switch, which must be taken out before it can be reversed, and in future torpedoes there will be an arrangement to prevent the circuit being completed through the primer until the motor has made a certain number of revolutions. Near the switch board at the directing station are placed a voltmeter and ammeter, to show what current is going away to the torpedo, and they also indicate at once when the torpedo has met with any obstruction, owing to the sudden extra work thrown on the motor. When working the torpedo from a ship in motion, the cable is to be paid out from the vessel as well as from the torpedo as required, so that in no case will there be any drag on the cable. A steamer was placed at Mr. Sims' disposal by Sir W. Armstrong, Mitchell & Co., of Newcastle-on-Tyne, for the purpose of testing the practicability of the invention at Portsmouth.

Naval experts are satisfied that an electric torpedo may be made to work successfully when once in the water. It only remained for Mr. Sims to show that he could launch one in a convenient and practical manner from a vessel in motion. One use which suggests itself for these torpedoes in our battleships is to take the place of the second class torpedo boats now carried by them, as they are well suited for at least some of the work which is expected of these boats.

One plan for launching from a ship is to hoist the torpedo out of an armor clad box on the upper deck, swing out, and lower the derrick to a drooping position, and when ready slip the torpedo. All this is more easily done than putting a second class torpedo boat over the side, and could be done in the course of an action, with the advantage of not having to send any men away from the ship on a very dangerous errand. The launching arrangement on the deck of the steamship Drudge consists of an inclined overhead traveler rail supported on stanchions, with a carriage on rollers working on the lower flange of the rail. The torpedo is hooked on to this carriage at both ends, and on being let go runs rapidly along until it reaches the portion of rail overhanging the water, clear of the ship's side, when it is tripped automatically, and enters the water with a slight dive. Our illustrations, from sketches by Captain Stephen, clearly show the method of launching from the steamer.

On Wednesday, February 3d, a trial run of the Sims-Edison electrical torpedo took place at Spithead in the presence of H.R.H. the Duke of Connaught and a number of distinguished military officers, including Colonel Sartorius, Colonel Cavaye, Major General Geary, R.A., Colonel Durnford, R.E., Captain the Hon. Henniker Major, Captain Hamilton, R.E., Colonel Brooke, R.E., Captain Lawrie, R.E., and Captain Burn, A.D.C., and others.

The duke having notified Mr. Sims that he would be ready to witness the run at 2:30 P.M., the s.s. Drudge, with the torpedo slung up in its launching position, went out of Portsmouth harbor at 11:30 A.M., under command of Sub-Lieutenant Vincent Stephen, R.N.A.V., and anchored off Spit Fort. Here the final touch was put on the preparations by connecting the extension beam of the traveler rail, which projects some distance from the ship's side, and cannot therefore be conveniently rigged out while in a crowded harbor like Portsmouth, for fear of fouling other vessels. Shortly after 1:30 P.M. the anchor was hove up, and the vessel steamed to the rendezvous off Fort Monckton, and at 2:30, with the punctuality for which the royal family are noted, the duke was alongside in one of the submarine mining steamers, from which the whole party were soon transferred to the Drudge. The duke was received by Captain Hamilton and Major Palliser, of the European Sims-Edison Electrical Torpedo Company, and Mr. Sims having been introduced to him, and then by him to the other officers, a move was made toward the torpedo, and Mr. Sims explained in detail the various sections and parts, the manner of launching and running, etc., to all of which the duke listened with evident interest. He was next shown the coil of cable which pays out from the ship's quarter through a projecting pipe, to keep it clear of the propeller, and then conducted on to the bridge to the small house which contains the controlling switches and other instruments, and which represents the conning tower. On a low shelf or table facing the door is the switch board.

On the left is the main switch for putting the current on or off; next to it is the firing switch, held in its normal position by an ebonite safety plug. With the firing switch in this position, the main current from the dynamo goes away to the torpedo in a certain direction through the outer core of the cable and works the motor; but if it is put over the other way the current is reversed, and then actuates a polarized relay which sends a shunt current through to the detonator, and so fires the charge. On the right is the steering switch, similar to the firing switch, but larger, which controls the current from a storage battery, and sends it through the inner core of the cable in either direction as required. This current actuates the steering relay in the torpedo, causing the main current on its way to earth from the motor to work the steering electro-magnets in the tail of the torpedo. The switch is so arranged that if the lever is set to the right, the rudder goes to the right, as also the torpedo; if to the left, the torpedo goes left; while if the lever is central, the current is cut off from the steering magnets, and the rudder assumes a central position by the action of the water. On the left of the switch-board are placed a Weston voltmeter reading up to 1,530 volts and an amperemeter reading up to 50 amperes. Above these is a large resistance box with a controlling handle for putting more or less resistance in the shunt of the dynamo, and so increasing or decreasing the current supplied, and therefore the speed of the torpedo, which may be caused to range almost instantly between five and twenty-one knots at the will of the operator. To the right of the resistance box is a double fuse on the main circuit, for safety in case of short circuit, and the only other instrument is an electric bell for signaling to the dynamo room.

All these things having been explained by Mr. Sims, he signaled to run the dynamo, and the men were stationed for launching the torpedo, and the steadying lines were cast off. The Drudge was put to full speed opposite Fort Monckton, and headed toward the Spit Fort, and the order was then given to launch. This was achieved by one man cutting a spun yarn stop, when the carriage being free to run along on the overhead beam, it started steadily, carrying with it the torpedo with its screw already in motion, and arriving near the end of the beam, the automatic tripper was actuated, and the torpedo dropped into the water with a slight dive, going well clear of the ship's side, and the current being increased, it at once gathered way, and started off on its journey. As the main object in view was to show the controllability of the torpedo, Mr. Sims did not put on the maximum current, but after running the torpedo to the left on a zigzag course for a short time to show its steering qualities, he ran it right across the Drudge's bows at a good speed, and finished off with an S curve in the direction of Gilkicker Point.

The next operation was the less interesting and more tedious one of picking up the torpedo and cable, and while the first was being done the duke and most of his party adjourned to the captain's cabin, where Mr. Sims showed, with the help of drawings and photographs, his various plans for launching the torpedo from a ship in motion, with all of which H. R. Highness seemed greatly interested. He then went down into the gun well which does duty for dynamo room, and inspected the engine and dynamo, thus completing his survey of everything connected with the working of the torpedo. Soon after this the duke and his party re-embarked in their steamer, and left the crew of the Drudge to pick up the mile and a half of cable, which was completed by 6 P.M.

The weather, which had been threatening during the forenoon, improved very much toward evening, which materially assisted the picking-up work. The sea was, however, very rough, owing to there being a fresh breeze blowing, and to the heavy gales of the preceding three days, notwithstanding which there was no difficulty experienced in launching and controlling the torpedo, which cut its way right through the opposing waves with a force which at times almost completely buried the float, eliciting from the officers a favorable opinion of its power and strength of construction, which should enable it to stand severe weather without injury.

Fig. 1.

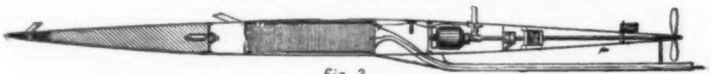
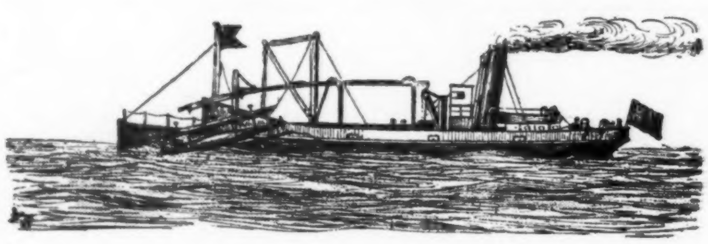
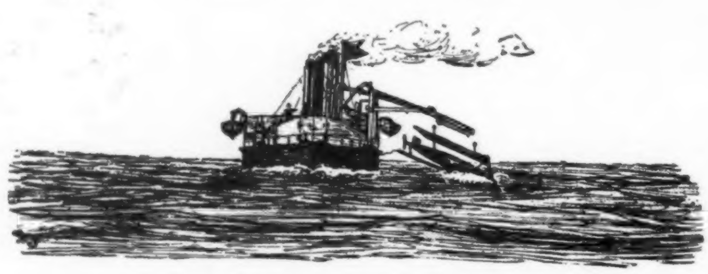


Fig. 2.

The Sims-Edison Electric Torpedo



FIRST STAGE OF LAUNCHING.



SECOND STAGE OF LAUNCHING

TORPEDO AFLOAT.

ELECTROLYTIC METHOD OF PREPARING METALLIC ALLOYS, ETC.

By H. N. WARREN, Research Analyst.

THE following method of preparing metallic alloys, such as silicides, chromides, bronzes, etc., has lately been satisfactorily followed. It differs slightly from the manner in which mercury amalgamates, or alloys, with other elements, owing to its liquidity. By substituting for the mercury, iron, copper, zinc, etc., these metals may be readily made to combine with the more oxidizable elements, such as silicon, boron, phosphorus, etc., by so arranging the process that the metal forming the alloy, when in a fluid state, is connected to the negative pole of a voltaic series, and in direct contact with the substance containing the element with which it is

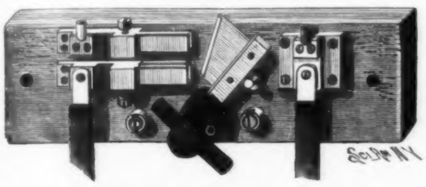
desired to combine it. The apparatus employed consists of a deep conical crucible, through the bottom of which is inserted a pointed graphite rod, projecting about an inch within, the remaining portion being protected by passing through an iron tube coated with borax, in order to prevent oxidation when exposing the same to an elevated temperature. The further extremity is next furnished with a binding screw or clamp, and connected negatively with the batteries employed, the whole arrangement being raised to a temperature sufficient to render liquid the metal introduced to form the alloy. Taking, for instance, the preparation of silicides, having introduced into the crucible a sufficiency of metallic copper, add sufficient potassium silico-fluoride to form when melted a layer about two inches in depth; a thick platinum wire is now arranged so that its point just touches the surface of the melted silico-fluoride (care being taken that the melted copper remains sufficiently low so as not to come in contact with the positive pole or platinum wire, otherwise the action is, of course, neutralized and the power of the batteries uselessly exhausted).

To this wire is connected the positive pole of not less than two large cells of the ferric chloride battery, when an instantaneous action is at once perceptible; dense white clouds of hydrofluoric acid are at once evolved from the platinum wire; the potassium silicofluoride becomes in part decomposed, the whole of the silicon thus set free uniting with the metallic copper, to form a brittle silicide. Phosphor and other bronzes may, by slight alteration, be also readily formed.

The earthy metals, barium, strontium, and calcium, have as yet not been satisfactorily obtained as alloys.—*Chemical News.*

HOW TO MAKE AN EDISON DYNAMO AND MOTOR.

THE SCIENTIFIC AMERICAN has repeatedly given detailed descriptions of small dynamos and electric motors copiously illustrated with first class engravings. These articles have enabled many mechanics and amateurs to construct machines which have proved more

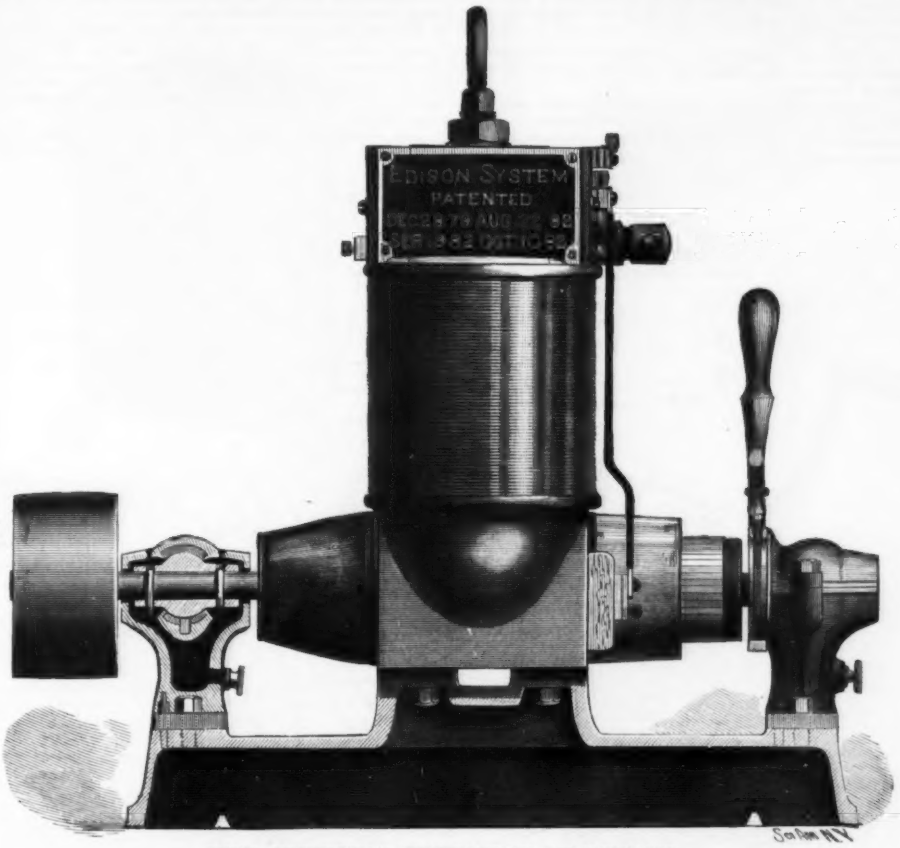


SWITCH ON THE EDISON DYNAMO OR MOTOR.

or less satisfactory, according as the work has been well or poorly done.

It is one thing to make a dynamo or motor from explicit instructions and quite another thing to design a machine adapted to generate or be operated by a particular current. The former is purely mechanical and within the range of most machinists and amateurs, while the latter is entirely within the province of the electrical engineer or electrician. When the work of machine building proceeds simultaneously with the study of fundamental principles, real progress is made. For the benefit of those who proceed in this way, and in answer to many inquirers, we give a detailed description of an Edison .25 kilowatt machine, designed for use as a dynamo for supplying a current for five Edison standard lamps, or for use on the Edison circuit as a quarter horse power motor.

Before beginning the description of the machine it is but fair to say that it is thoroughly well made in every particular. The insulation in every part is very perfect, and the whole is so well made that any single machine built by a mechanic or amateur could but suffer by comparison with it; and furthermore, we doubt if any maker of a single machine could even



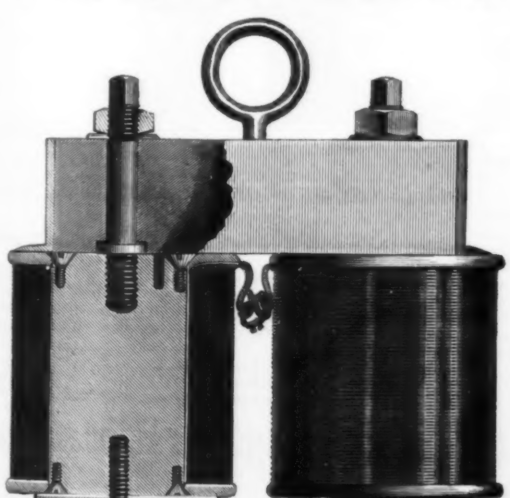
SIDE SECTIONAL ELEVATION OF DYNAMO.

purchase the materials required for the price asked for the machine by the regular manufacturers. Therefore, if the machine is wanted, we advise a purchase. If experience is wanted, the making of the machine comes first in order, with a probable purchase to follow.

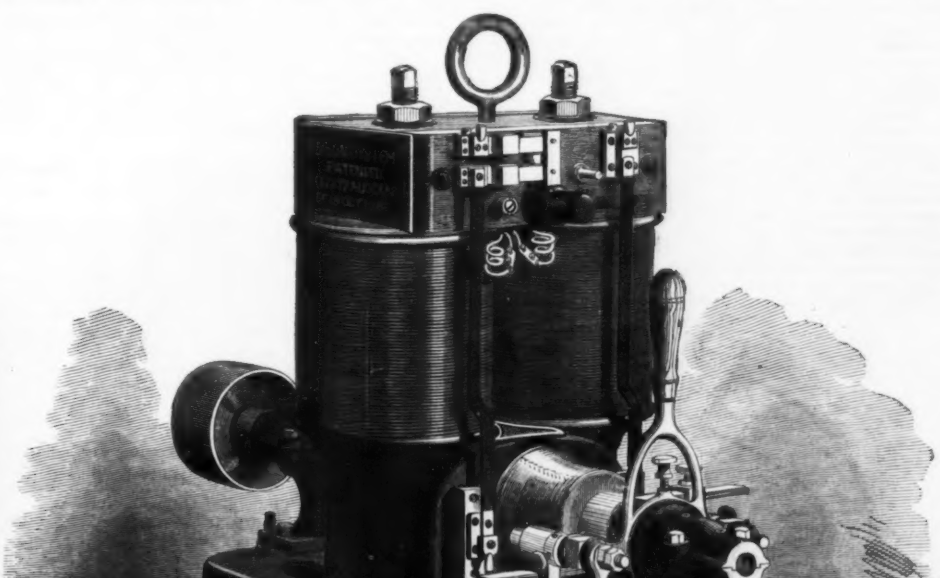
The engravings are one-third the actual size, linear measurement.

The base, which is of brass, is made hollow, as shown. It is 14 in. long, 7⅜ in. wide, 1¾ in. deep at the ends, with two 1⅛ in. elevations at the middle for receiving the cast iron pole pieces of the field magnet, which are each secured to the base by two small tap bolts extending upwardly through the base and into the pole pieces.

The upper surfaces of the pole pieces are truly faced for receiving the cylindrical field magnet cores, which are made of Swedish iron, 2⅝ in. in diameter and 4½ in. long. These magnet cores are each held in position by a threaded stud screwed into the pole piece and entering magnet core. Each core is provided with a vulcanized fiber collar at each end, which is ¼ in. thick and ⅞ in. wide. Upon each core, and between the fiber collars, is wound 5¼ lb. of No. 24 silk-covered copper wire, with a wrapping of thin varnished paper between the layers. The cores, before winding, are thoroughly insulated with the same material. The fiber collars are each held in place by three conical-headed screws entering the end of the core, with their heads projecting beyond the body of the core. To the inner and outer ends of the winding of each arm of the magnet are attached pieces of larger wire to avoid breakage, and the inner ends are led out through grooves in the fiber collars. The yoke, of Swedish iron, is 2⅝ in. wide, 2⅛ in. thick and 7½ in. long. It is held in position on the cores by two ⅛ in. bronze studs, each threaded at the upper and lower ends, and



SIDE VIEW OF FIELD MAGNET, PARTLY IN SECTION.



SMALL EDISON DYNAMO OR MOTOR.

furnished with a collar which fits into the counter-bored part of the hole in the yoke. The studs are squared at the upper end to receive a wrench, and a nut is placed on each stud above the yoke for clamping it securely after adjustment. The machine is regulated or adapted to any work requiring less than its full power by raising the yoke more or less. The yoke is provided with an eye, by means of which the machine may be lifted.

Front and rear boards of mahogany are arranged on opposite sides of the yoke, and held in place by brass plates at the ends.

The outside ends of the field magnet coils are connected with binding posts on the rear board.

A variable resistance of ten or fifteen ohms is inserted between these posts when the machine is used as a

grooves formed in the inner surface of the journal box. The surplus oil drops back into the hollow standard. A screw plug in the lower portion of the standard allows of the renewal of the oil. The bearings at opposite ends of the machine are alike, except that the cast iron support of the bronze journal box, at the commutator end of the armature, is turned on its inner end to receive the brush yoke.

The steel armature shaft is 16½ inches long and ½ inch in diameter at the journals, and $\frac{11}{16}$ inch in diameter between the journals. The larger part of the shaft is 9½ inches long. Sufficient end chase is allowed in the armature journals to cause the surfaces to wear smoothly.

On the central portion of the armature shaft is placed a wooden sleeve, $1\frac{1}{16}$ inch in diameter; on

in jute string ribbon to a point within the end of the armature core, and it is further protected by a wrapping of thin adhesive tape. The outer end of the coil is covered in the same way.

About three pounds of No. 21 wire are required for the armature. The length of wire in the first inner coil is 26 feet 6 inches. The length of wire in the last outer coil is 35 feet.

The commutator cylinder* is formed of 32 bronze bars having beveled ends and radial arms for receiving the wires. These bars are clamped in position on a sleeve having an under-cut flange, by a countersunk washer and a nut screwed on the sleeve. Mica is inserted between the commutator bars, between the bars and the sleeve, and between the ends of the bars and the flange and the washer. The radial arms extending from the

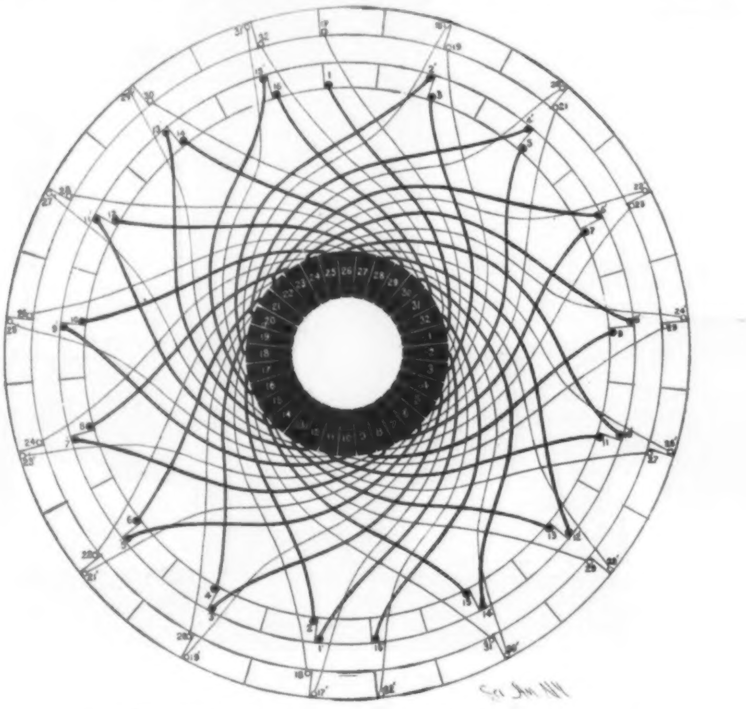


FIG. 1.—DIAGRAM OF WINDING OF EDISON ARMATURE.

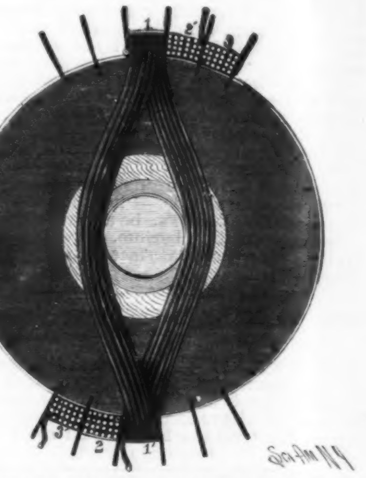


FIG. 3.—ARRANGEMENT OF THE LAYERS AT END OF ARMATURE CORE.

commutator bars each have a slot in the end for receiving the terminals of the coils.

The coil terminals are arranged in groups of 16, the wires of each group being parallel. The terminals are carried around and attached to commutator bars which are about 90° from the planes of the coils to which they belong, thus making the winding more symmetrical and at the same time permitting of a better arrangement of the brushes.

The coil terminals are inserted in the slots of the arms of the commutator bars and soldered with soft

dynamo. In the front board, at the right hand side, is secured a bronze casting known as the right hand motor head field magnet terminal. This is adapted to receive the line wire, also one of the leads, the upper end of which is screwed to the casting. The lower end of the lead is secured to a lead terminal attached to a block of wood secured to the right hand pole piece. At the right hand side of the machine a similar arrangement of the lead is found, but the upper lead terminal is made in two separate parts, one attached to the lead, the other being connected with the line; both being furnished with copper switch tongues. The switch arm turns on a stud projecting from the front board and carries a loose triangular switch plate of copper, having a knife edge which readily enters between the switch tongues. The switch has a T-handle of hard rubber, by means of which it is turned. A stop pin projecting from the front board limits the rearward movement of the switch arm.

The inside end of the right magnet coil is connected with the right hand lead, and the inside end of the left hand magnet coil is connected with the lower half of the left hand lead terminal.

At opposite ends of the base there are plane surfaces to which are secured the self-oiling bearings of the armature shaft. Each bearing has a hollow standard furnished with a cap, which, together with a cross piece in the hollow standard, forms a support for the spherical central portion of the bronze sleeve forming the journal box proper.

This sleeve is shorter than the outer portion of the

this are mounted the thin sheet iron disks forming the armature core. These disks are 2⅝ inches in diameter. They are arranged in series of five, with tissue paper between the disks, and between the series of five are placed several thicknesses of paper. Enough disks are clamped together on the shaft to make this portion of the core 3½ inches long. The cast iron disks between which the sheet iron disks are placed are ¼ inch in thickness and 2⅛ inches in diameter. One of them is fixed on the shaft, the other being held in place by a hexagonal nut screwed on the shaft. The cast iron disks have their outer corners rounded, and in the edge of each are formed thirty-two equidistant radial slits $\frac{1}{32}$ inch wide. In these slits are inserted slips of vulcanized fiber for separating the different pairs of coils during the operation of winding.

It is impossible to describe the Edison winding without depending mainly on the diagrams, Figs. 1 and 2. There are two series of coils; that is to say, there are two coils in each division of the armature. There are thirty-two bars in the commutator, which are numbered consecutively from 1 to 32.

The armature core and shaft are thoroughly insulated by means of paper coated with an adhesive varnish. Jute string ribbon is wound on the face of the core as a further protection.

The wire used on the armature is No. 21 copper wire, double covered; the inner covering being of silk, the outer of cotton.

Leaving an end out for connection with the commutator coil, No. 1 is begun at 1 and wound in four layers, with six convolutions in each layer, the outer terminal coming out at 1'. These ends are marked respectively 1 and 1' in such a manner as to avoid any possibility of the detachment of the marks. If this caution is observed, much trouble may be avoided. A good way to mark them is to place a tag of parchment, or parchment paper, on each end of the wire, with the number marked on.

After winding coil No. 1 the armature is turned half way over and coil No. 2 is wound and marked in the same way, with 2 on the inner end of the coil and 2' on the outer end. The coil is then reversed and coil No. 3 is wound and its ends are marked in the same way,

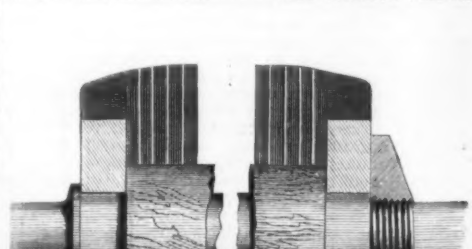


FIG. 4.—THE ENDS OF THE ARMATURE CORE.

solder, the connections being made in accordance with the diagram, Fig. 1.

The wires, where they cross at the back and front end of the armature, are separated by sheets of mica. Where the winding crosses at the rear end of the armature the wires are spread out so that they are only one layer deep.

When the winding of a coil is finished, the terminal is fastened by stout threads inserted in the coil before winding the last three convolutions, and tied after the coil is complete.

A vulcanized fiber collar, a little larger in diameter than the commutator, is slipped over the commutator

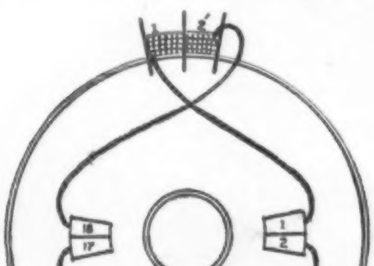


FIG. 2.—THE FIRST TWO COILS AND COMMUTATOR CONNECTIONS.

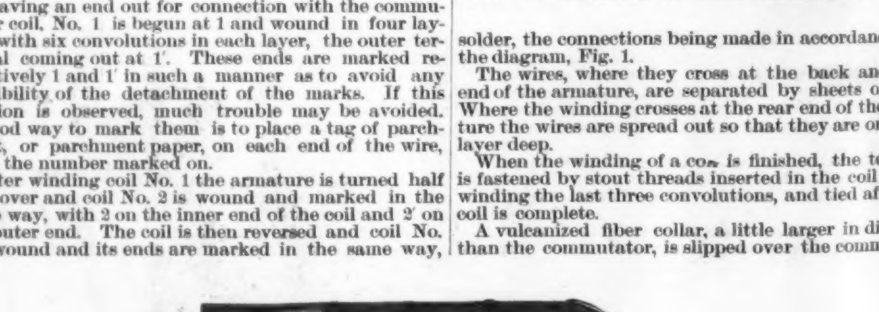


FIG. 5.—THE ARMATURE WITH PARTS BROKEN AWAY.

bearing, and is slotted across the top to allow two brass rings to ride upon the armature shaft. These rings dip in the oil in the hollow standard, and as they revolve carry oil to the shaft in quantities more than sufficient for the purpose of lubrication. The oil is distributed throughout the bearing by means of spiral

and so on until the first series of coils is finished, the last coil of the series being marked 16 and 16'.

The first coil of the outer series is No. 17-17'. This is wound on the top of coil No. 1. The armature is turned over and No. 18 is wound on the top of No. 2, and so on until all of the outer coils are in place.

Before winding, the inner end of each wire is wrapped

bars and placed against the radial arms of the bars as shown. The edge of the collar is grooved and a canvas cover is fastened to the collar by tying it in the groove. It is then drawn over the terminals and fastened by the first ring of binding wire on the armature. At the

* For further points on commutators see SUPPLEMENT, 600.

opposite end of the armature a similar collar and cover is provided.

Before covering the terminals with the canvas they are wound with twine to give the end of the armature a symmetrical shape. The winding is varnished with shellac before its cover is applied, and the cover is varnished after it is secured in place.

The binding rings are formed of brass wire, wound tightly over a layer of mica interposed between the wire and the binding. The binding wire is secured by clips and soft soldering.

The brush yoke is provided with wooden handle by which it may be moved and a binding screw by which it is clamped in the position of use. In mortises in the ends of the yoke are placed insulating blocks, in which are inserted the brush-holding studs. These studs are each provided with a nut for clamping the brush holder cables which communicate with the leads at the side of the pole pieces.

On each brush-holding stud is placed a sleeve fastened with a set screw, also a loose sleeve connected with the fast sleeve by a spiral spring concealed within it. The loose sleeve is furnished with a brush clamp for holding the brush, which bears on the commutator cylinder with a yielding pressure. The brushes are formed of spring copper wires fastened together at their outer ends with soft solder.

FIG. 6.—THE BRUSH YOKE.

A jig goes with each machine for clamping the brush and guiding the file while renewing the brush ends.

The speed of the motor on a 125 volt circuit is 2,400 revolutions per minute. The speed at which the armature is to be driven in order to generate a current having an E. M. F. of 125 volts is 2,730 revolutions per minute.

Since the first part of this article appeared in our issue of July 25, we have received a letter from the Edison General Electric Company, stating that the machine here described, according to the new rating, which went into effect June 15, is a 0·5 kilowatt machine, which, when used as a generator for supplying lights, will generate sufficient current to bring to full candle power nine 16 C. P. 112 volt lamps, and when used for power it is a ½ horse power motor at a rated volt. It is guaranteed to give 0·47 horse power at ⅞ of its rated volts.

We are also reminded by this letter of the fact we neglected to state in our former article, which is that this form of machine is a type which was brought out in 1885, and is known as the Standard Edison machine, which is made in several sizes. Each size is identical, in its general construction, with the machine described, and any of the machines can be used either as a dynamo or motor.

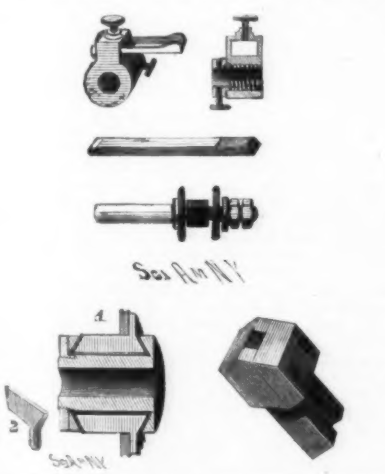


FIG. 7.—DETAILS OF THE BRUSH HOLDERS, THE COMMUTATOR CYLINDER, AND BRUSH-HOLDING JIG.

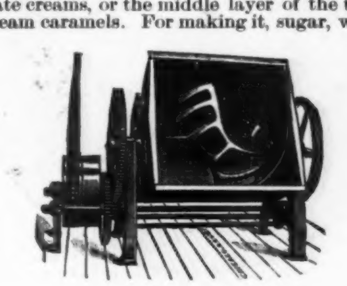
HOW CANDY IS MADE.

THE basis of all candies, of course, is sugar, to which is added a great variety of other substances, such as the manipulation, and the special kind of candy to be made, or the quality, may demand, as, for instance, glucose, which enters to quite an extent into candy for the purpose of attaining a certain consistency in the mixture of ingredients and to prevent the mass from "graining off."

Another important material which enters very largely into the manufacture of candy is starch, whose principal object is to secure a certain softness in the finished product, as is found in gum-drops, chew-chews, marshmallows, etc. It is hardly necessary to mention that water also plays an important part in the "batch" of candy. Furthermore, there are innumerable special ingredients, for special purposes, such as flavors, colors, nuts of all kinds, cream, etc., required in the art of candy making.

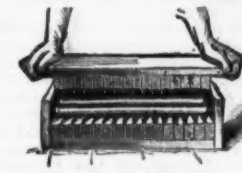
Naturally the furnace is the first piece of machinery to which we direct our attention in the factory. It is about two and a half feet high, varying in its outer diameter from say fifteen to twenty-four inches. It is made of sheet steel, with a lining of fire brick, and is provided at the top with a number of rings, so that any sized kettle or pan may be placed on it. For some kind of candy this is the only piece of machinery, with the exception of perhaps a knife, which comes into play. If caramels are to be made, there are placed in the kettles sugar, glucose and cream, which are boiled together. The coloring in this case is supplied by the heat during the boiling, the mass turning to the beautiful brown color which adds so much to the popularity of caramels. There are, of course, certain kinds which are given the color of strawberries, or to which chocolate is added for flavor as well as color. After boiling sufficiently, the contents of the kettle are emptied on a well oiled marble slab. The boiling has been regulated in such a manner that the hot mass will, of its own accord, run out on the slab until of a thickness of the ordinary caramel, but iron bars are placed on the slabs, which prevent the candy from running off. When cooled off the bars are removed, and the slate of candy, as we might call it, is marked, either by machine or hand, to serve as a guide for the cutter. The cutting is done by hand in many cases, although machines have been provided for the purpose.

The next machine shown is a batch-mixer, such as is also used by bakers in mixing their dough. It is used for making "candy cream," of which most hand-made candy consists, and which also forms the inside of chocolate creams, or the middle layer of the three-colored cream caramels. For making it, sugar, water and glucose are placed in a copper kettle and boiled on the above-mentioned furnace. When sufficiently boiled it is poured on a marble slab, and, after cooling off somewhat, poured in the mixer, and stirred or churned by means of the revolving blade shown until it has become a white, thick mass, which, on cooling, completely "sets" into the well-known cream.

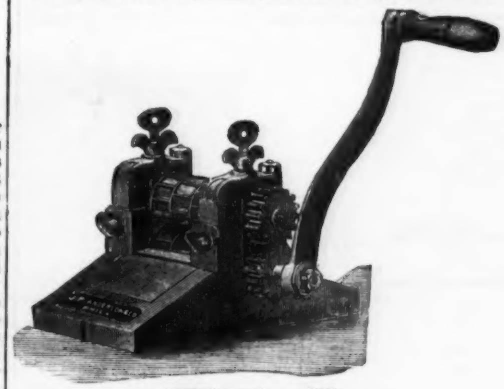


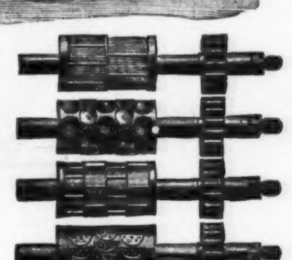
We now come to the manufacture of stick candy, which will remind many of our readers of the good old fashioned candy pull which we used to enjoy when we were boys. There is not quite as much fun about it in the factory, and in several other respects also the proceedings are slightly different. The ingredients are boiled as before, but at a very high heat, poured on the marble slab, cooled and flavored. The batch when cooled enough to be handled is hung over a hook and the ends pulled out, then doubled up again over the hook and again pulled, and so on until the pulling has made the candy as light in color and as hard as is required for stick candy. During the pulling differently colored batches are sometimes worked on hooks close to each other, and when both are sufficiently pulled, they are made into one short and immensely thick stick; by placing say red stripes around a white center and pulling this mammoth stick of say fifty pounds weight out lengthwise, thus forming very long and thin sticks, retaining the same design as the original block, only, of course, greatly reduced in size. These long sticks are then cut up into short sticks, as found on the market. The number of designs possible to be made in this manner is practically unlimited, and the candy having emblems, such as flowers, flags, faces, etc., is made on the same principle.

Out of this stick candy, if wanted, candy balls or marbles can be made by means of the machine illustrated below. The latter is essentially a hardwood box, in which ten or twelve saws are fastened on the lid, and an equal number at the bottom. Seven or eight pieces of stick candy, about one foot in length, are placed between the two sets of saws, and the upper portion of the machine is then worked to and fro until the sticks have been cut into sections and falling into a small dish that is placed under the machine. From this dish they are at once removed and placed on a wooden table until round and cool enough to prevent them from flattening out.



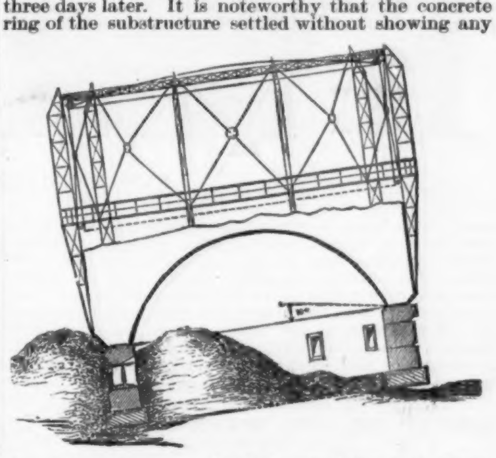
The last cut shows a machine that is used for hard-boiled sugars, as lemon drops, mint fishes, etc. Instead of pulling the batch of candy on this hook, as is done with the preceding one, the candy that is to be worked through this machine is boiled and then sufficiently cooled off to facilitate handling. It is then fed into the machine, in which have been fastened the rollers for the shape intended, which may be, as said before, drops, fishes, or any other fancy design.—*Confectioner's Journal.*





A GASHOLDER DISASTER.

THE accompanying illustration, which is reproduced from the *Journal fur Gasbeleuchtung*, represents the settlement, as it appeared in November last, of a gasholder erected at Constance in the course of the previous year. The drawing explains itself; but it was reported in our German contemporary that the tank sank in consequence of the bad subsoil and an insufficient foundation. The occurrence so wrought upon the nervous temperament of the engineer (Herr August Raupp) that in a moment of despair he committed suicide. The settlement began on October 31, and the sketch from which the engraving was made was taken three days later. It is noteworthy that the concrete ring of the substructure settled without showing any other failure than a crack in the sill of the door giving access to the vault under the tank. The whole structure went together so gently that not a pane of glass in any of the ten vault windows was cracked. The settlement of the foundation squeezed up the earth as shown. The diameter of the tank was 24 meters; and the foundations were 3 meters in height, of which the concrete measured 1 meter in thickness, and the rest was a sandstone wall. The tank was 15 meters deep. The water weighed 1,770 tonnes; the ironwork, 140 tonnes; and the masonry, 673 tonnes. The total weight upon the subsoil was 2,583 tonnes, distributed so as to throw a pressure of 18 tonnes per square meter upon the ground covered by the concrete. The subsoil is first



loam, underneath which is alluvial mud, plainly in communication with the water of the Bodensee ; so that a yielding slush is formed, which was the occasion of the catastrophe. At first the tank settled equally, and maintained a fair level ; but eventually it lunged over quite suddenly in the position shown.—*Jour. of Gas Lighting.*

NEW BREWING APPLIANCES.

THE new brewing appliances which we illustrate have been brought out by Llewellins & James, of Bristol. The first of these is Birrell's antiseptic hot grist mashing apparatus, which is illustrated at Fig. 1. In this system the heat from anthracite coal is filtered and forced into the grist, thereby imparting to it certain antiseptic properties, which, it is said, never leave the resulting worts. It expels all moisture, increases the dextrine, and strengthens the albuminoids. All the air used is sterilized and freed from atmospheric germs, and it is reported to be a very valuable invention for restoring slack malt and imparting antiseptic properties to the grist.

Fig. 2 represents a vertical section and Fig. 3 a plan of Leaker & Reffell's cone furnace and setting for brewers' fire coppers. This invention is designed to concentrate the heat from the fire directly on to the center of the copper bottom by means of the fire brick

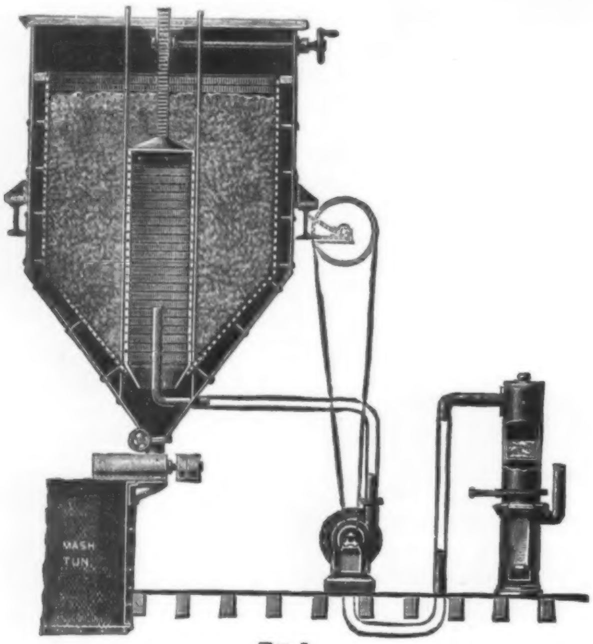


FIG. 1.

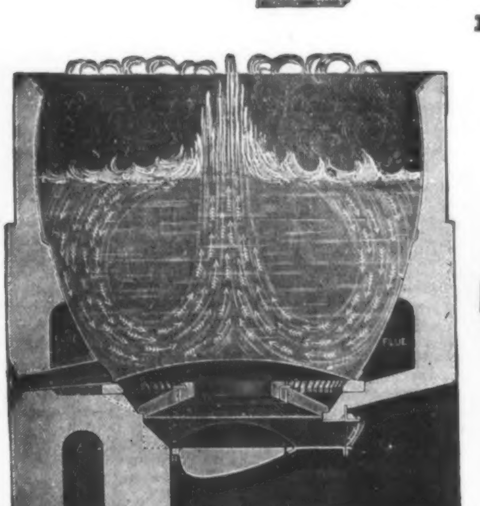


FIG. 2.

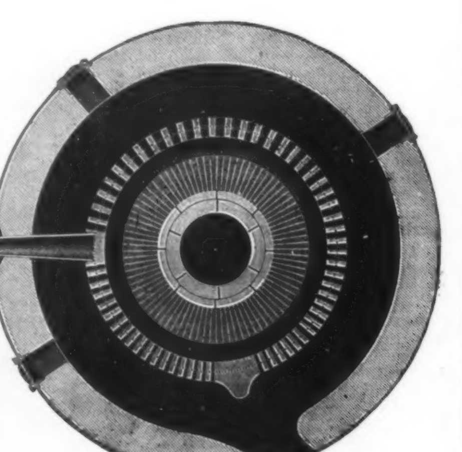


FIG. 3.

NEW BREWING APPLIANCES.

cone. It is found to give a thorough circulation of the wort, and a heavy central boil, thereby insuring proper aeration and effecting a saving in fuel. By reason of the circulating action of the wort, as shown in our engraving, it is prevented from boiling over, and when in work it is found that the wort is quiet around the sides of the copper under a most vigorous boil. There is no fear whatever of the copper being burnt, by reason of the effective circulation set up by the impact of the fire through the cone.—*Iron.*

LINSEED OIL AND OTHER OILS USED IN ART PAINTING.*

By Prof. A. H. CHURCH, M.A., F.R.S.

THE common usage of the term "oil" is wider and less definite than that sanctioned by chemists. We must exclude from the category of true oils petroleum and the liquid paraffins, spirits of turpentine, and the volatile essences of plants, the hydrocarbons of coal naphtha, as well as a number of other liquids which present certain superficial resemblances to the oils proper. Fats, however, belong to the same group, their solidity at ordinary temperatures being, so to speak, an accidental rather than an essential difference.

The true oils are often called fixed oils, for they cannot be boiled and distilled without change, thus differing from really volatile liquids. They are *glycerides*—that is, compounds from which glycerin, on the one hand, and fatty acids, on the other, are obtainable. These glycerides are named after the fatty acids which they yield. Thus olein is the glyceride of oleic acid, linolein the glyceride of linoleic acid. In reality three kinds or varieties of glycerides of each fatty acid are possible, but the oils used by painters consist almost entirely of one of these kinds. The formation of one of these glycerides may be expressed in words thus: One molecule of glycerin, reacting with three molecules of a fatty acid, yields one molecule of glyceride in question and three molecules of water. Conversely, under other conditions, one molecule of a glyceride, reacting with three molecules of water, produces one molecule of glycerin and three molecules of fatty acid. If, in this last reaction, we substitute for the water three molecules of an alkali, such as potash, we obtain glycerin as before; but, in lieu of the free fatty acid, we find that an alkaline salt of the fatty acid has been formed—such salt is a soap. Alkaline soaps, namely, those of potash, soda, ammonia, are soluble in water, which fatty acids are not. There are, however, other soaps which are insoluble in water, namely, the lime, lead, copper, and many similar metallic salts of fatty acids.

Oils, though insoluble in water, are easily soluble in spirit of turpentine, benzine, chloroform, liquid paraffins, and volatile plant essences; they are, in fact, miscible in all proportions with these liquids. There are other liquids in which the oils are less soluble, such as alcohol, ether, and glacial acetic acid.

Oils are divisible into two classes, one of which includes those which dry up and harden, forming a kind of elastic varnish, by exposure to the air. The oils of the other class do not harden, but become sticky and rancid in smell; these oils, however, if submitted to the temperature of boiling water for some time, in some instances become dry and hard, but the varnish they yield under these circumstances is dark in color and brittle. The painter's concern is almost exclusively confined to the oils of the first group, generally known as *drying* oils. To the most important of these attention will be directed presently, but the general methods of extracting them first demand a few words of explanation. There are two different processes in use. In one of these, which has been practiced widely from very early times, the oil is obtained by pressure; in the other process, invented some fifty years since, the oil is extracted by means of an appropriate solvent. We may dismiss this latter process almost summarily, for the product which it yields, though much greater in quantity, is decidedly inferior to that obtained by pressure. It is less fluid, and contains a larger proportion of solid fats. The solvent commonly employed to dissolve out the oil from oil-yielding materials is carbon bisulphide (CS_2), a compound of carbon and sulphur, which may be prepared cheaply by passing the vapor of sulphur through red hot charcoal. Of the pressure process for obtaining fixed oils there are two modifications. In the more usually adopted of these, the oily seed or other material is first heated, and then pressed while still hot; in the other modification the pressure is applied to the cold seed, etc. Heat and pressure give a more abundant yield of oil, but the product is less pure and less well fitted for use in painting. The bulk of the oils of commerce are thus obtained. Cold pressed oils remain clear in cold weather, are more fluid than hot pressed oils, and contain a smaller proportion of solid fats and of free fatty acids.

The most important drying oils are those of linseed, poppy seed, and walnut kernels; others are obtained from niger seed, sunflower seed, and hemp seed. The first place is due to linseed oil.

Linseed oil is obtained from the seed of the common cultivated flax (*Linum usitatissimum*). Linseed varies in size and color. The usual colors are a purplish brown and a reddish brown, but there is a nearly white sort—a mere sport or variety—which may be said to be straw colored. It is grown along with the brown variety in some parts of the northwest provinces of India, particularly in Nagpur, but no pains are taken to keep the strain pure. Through the kind offices of the Director of the Royal Gardens, Kew, the government of India were good enough to obtain a specially pure sample of some hundredweights of white Nagpur linseed, and to place it at my disposal. Attempts to grow it for seed in this country and in Belgium failed, but a large quantity of oil was expressed for trial and analysis. Messrs. Bell & Co., of 225 Oxford Street, obtained several gallons of oil by cold pressure; many artists have expressed their approval of the product. One advantage of this white seed is the ease with which the purity of a sample may be recognized by the eye, any accompanying weed seeds differing widely in color from the white linseed. The skin of the seed is, moreover, thin, the cold drawn oil is nearly colorless, and the seed is particularly rich in oil, containing no less than 45 per cent. of its weight, although, of course, much less than this proportion is obtainable by cold pressure. In a hand press about 25 per cent. was the average yield. Of the common or brown linseed, our chief supplies come from Russia and India. The Russian seed is generally finer than the East Indian; it is, moreover, imported in a less mixed and impure condition. By screening, the greater part of the impurities are or may be removed, but it is sold on a basis of 4 per cent. impurity. The impurities consist of dirt, other oil seeds, such as mustard, rape, and gold of pleasure, and non-oily weed seeds. The presence of the last named, though it reduces the yield, is not otherwise objectionable,* but the same remark does not apply to the foreign oil seeds. Most of these contain non-drying oils, which mingle with the linseed oil when the sample is pressed and deteriorate its quality.

The percentage of oil in linseed varies between 28 and 45; by cold pressure 20 per cent. is the average yield; by hot pressure, 27 per cent.; by extraction with carbon disulphide, 33 per cent. The linseed oil in common use by artists is hot pressed oil, and is very rarely, if ever, obtained from absolutely pure seed. The seed should be kept three months before it is pressed. The expressed oil should be exposed to light in covered glass vessels or tanks, and kept at a temperature of 80° or even 100° F. for some time. It thus loses color and becomes clear, a slimy deposit being formed. When thus bleached and clarified, the oil should be preserved in corked bottles filled quite full; the longer it is kept the better it becomes for painting, provided the access of air is prevented. The specific gravity of good linseed oil varies very little. At 60° F. (15·6° C.) it is 0·935; a bottle which will hold 1,000 grains of water at this temperature will therefore hold but 935 grains of linseed oil. It expands considerably with heat, its specific gravity at 50° C. being 0·913 only. One part of linseed oil requires 36 parts of cold absolute alcohol for solution, but only four parts of boiling alcohol. It may be purified by solution in boiling alcohol or in petroleum ether. Other methods of purification are generally employed. Among these may be named the following: Filtration through felt or carded cotton and charcoal, and then through pyrolusite; agitation with a solution of common salt, followed by washing with water, and drying by a heat of 220° F.; treatment with one four-hundredth part of oil of vitriol, addition of hot water, washing, and drying. Various other processes and reagents have been employed for purifying and bleaching linseed oil. Aqueous solutions of sulphurous acid, green vitriol, potassium permanganate, potassium bichromate, and peroxide of hydrogen may be included in this list. The addition of 1 per cent. of oil of turpentine to the oil, and then passing a mixture of air and steam through it, has also been tried. Whatever process be adopted, no acid, saline matter, or moisture must be left in the oil. The general and usual result of all the very different kinds of treatment to which linseed oil is subjected, in the above named and in many other processes, seems to be the more or less complete removal of impurities. The effect on the properties of the purified oil is chiefly seen in its greatly increased rate of absorbing oxygen and consequent hardening.

The chemical composition of linseed oil may now engage our attention. Its ultimate analysis shows it to vary according to the method of extraction adopted, cold pressed oil containing about 78 per cent. of carbon, 11 per cent. of hydrogen, and 11 per cent. of oxygen; while the hot pressed oil contains nearly 3 per cent. less carbon, and nearly 3 per cent. more oxygen; linseed oil extracted by carbon disulphide is still poorer in carbon, and richer in oxygen. Linseed oil consists chiefly of four glycerides, called, respectively, linolein, linolenin, isolinolenin, and olein. A small, but variable, amount of free fatty acids is also present. The empirical formulæ of the four fatty acids of the above named glycerides are, respectively:

Linolenic acid } Isolinolenic }	$C_{18}H_{30}O_2$
Linoleic	$C_{18}H_{32}O_2$
Oleic	$C_{18}H_{34}O_2$

Linolein, which is present in linseed oil to the extent

* Abstract, from the "Chemistry of Paints and Painting." By A. H. Church.

* Occasionally these weed seeds give up, under pressure, certain matters which deepen the color of the expressed oil somewhat.

of about 20 per cent., is the glyceride of linoleic acid, and has the formula $(C_{16}H_{27}O)_3$, C_3H_5, O_3; or, as it may be written, $C_3H_5 (O, C_{16}H_{27}O)_3$. The relation of this glyceride to glycerin may be seen when the latter body is expressed by the formula $C_3H_5(OH)_3$. It is probable that the two other main constituents of the oil—linolenin and isolinolenin—are similarly constituted glycerides, and that they closely resemble linolein in physical and chemical properties. When 100 parts of linseed oil are saponified by an alkali, they yield from 9·4 to 10 parts of glycerin.

The most important chemical property of linseed oil, from a painter's standpoint, is its behavior with oxygen. Under certain circumstances it absorbs oxygen to the extent of 12 or 13 per cent. of its weight, becoming converted into a mixture of substances for which it is convenient to retain the old name *linoxine*. Linoxine is solid, and not liquid; it is far less soluble than linseed oil in any solvent, and in many liquids it is insoluble. Linoxine is, moreover, denser than the original oil, and is also more bulky; 100 grains of linseed oil produce about 108 or 109 grains of linoxine. During the oxidation of linseed oil, the small quantity of olein it contains remains unoxidized, and its presence confers elasticity upon the product. The changes which occur during this oxidation are complex and ill understood; but there is some formic acid formed, so that the product is sour; carbonic acid gas and water are also produced. There are many ways of bringing about this oxidation. A very common one is to heat the oil to a temperature of at least 100° C., and to blow air through it, or air containing ozone. Many substances favor the absorption of oxygen by linseed oil under the above conditions. Among these may be named manganese dioxide, borate, oxalate, or linoleate; red lead, litharge, or lead acetate; green vitriol or white vitriol, etc. It is better to use one of the manganese compounds, and an excellent result is obtained with the borate of this metal. On the small scale the operation may be thus carried out: Tie up in a small piece of muslin 20 grains of dry and powdered manganese borate. Suspend the bag in a glass quart flask, into which a pint of linseed oil has been placed, so that the bag is just covered by the oil; lightly plug the mouth of the flask with some carded cotton. Stand the flask in a warm place, where the temperature does not fall below 40° C. nor rise above 100° C. In a fortnight's time the oil will have become strongly siccative, so that when it is spread in a thin layer on glass or paper, it will dry up to a tough varnish within twenty-four hours. If the oil and manganese borate be maintained by means of a water bath at a temperature of 100° C., the change will occupy less time, and the product will be just as good; but it is not advisable to *boil* the oil with the borate, although the change may be thus effected in less than an hour. The oxidation may be further hastened by occasionally blowing a little air into the oil through a glass tube kept permanently in the flask. When the rapid drying quality of the oil has been proved, by experiments made with a drop or two withdrawn for that purpose, the flask is allowed to get cold, and the oil poured into a corked glass bottle so as to fill it. In the course of the next few weeks, a slight deposit will be formed in the bottle; when this has occurred, the clear oil should be poured off into other bottles, and preserved for use. According to the purpose for which the prepared oil is to be afterward used, the treatment with the borate is to be more or less prolonged; but care should be taken not to carry it so far that the oil becomes ropy or viscous, unless it is intended to make linseed oil varnish. We shall often refer to this siccative linseed oil as "manganese oil." To the above directions for preparing this oil may be added the remark that if the operations be conducted in strong light, the oil will be bleached as well as rendered highly siccative. No satisfactory explanation of the action of the manganese borate (and of many other substances used for the same purpose) has been offered. But it seems probable that the absorption of oxygen by the oil is favored by the removal of certain impurities, and this the borate of manganese may effect.

The increasing specific gravity of the "manganese oil" as the process is prolonged may be used as an indication of the point at which the heating may be discontinued. When the oil has acquired a specific gravity of 0·945, it is generally sufficiently siccative for grinding with non-drying pigments, and as an addition to certain varnishes. For these purposes it may even attain a specific gravity of 0·96; but when it shows 0·99, or 0·995, it constitutes a thick varnish, which needs dilution with a suitable solvent. It may be well to remark here that the various processes for rendering linseed oil more rapidly drying may be regarded as resulting in two actions, partly consecutive, partly simultaneous. The first action, if it could, or did, occur alone, would yield a purified oil *apt* to dry quickly, but very slightly altered in composition; the second action is more profound, and gives rise to a thickened, denser product, in which the drying process has already commenced. In practice, the first action occurs almost, but not quite, uncomplicated with the second, when linseed oil is warmed with borate of manganese in a vessel to which atmospheric air has very limited access; the second action, which is of necessity associated with the first, takes place when a stream of air is blown through warm linseed oil, even in the absence of manganese borate, but far more quickly in its presence.

The superiority of the highly siccative oils prepared with borate of manganese (or the oxalate) over those in the manufacture of which lead compounds or white vitriol are used, is so decided that all description of the older and less satisfactory methods will be omitted. But there are two other ways of rendering linseed oil more siccative, which deserve a passing notice. Into a clear glass quart bottle an ounce of distilled water and an ounce of clean iron brads are first placed, and then one pint of raw linseed oil, agitation being avoided. The next day the bottle, placed in as strong a light as possible, is to be shaken frequently, the shaking being repeated every day, until a drop of the oil, when tested, shows a sufficient degree of drying character. Finally, the liquid part of the mixture in the bottle is poured into a separating funnel, and the aqueous part allowed to run away. The oil may require drying and filtration. In another similar process green vitriol is substituted for the metallic iron, the other directions being identical.

The most important property of linseed oil and some methods for the further development of this property having been discussed, we may now describe the remaining characters of this oil. The cold pressed oil is very pale straw colored, or pale yellow, with occasionally a faint greenish hue; the hot pressed oil is a darker yellow or brown. The cold pressed oil, when considerably cooled, remains clear long after the hot pressed oil has become turbid. The fluidity of the oil is less than that of water in the ratio of 1:10. The hot pressed oil has a much stronger taste and odor than the cold pressed oil.

The adulteration of linseed oil with other oils may be recognized with more or less precision by means of several different tests. Most of these tests (oil of vitriol test, nitric acid test, etc.) produce reactions in which the oil and the acid acquire varied colors characteristic of different oils. The tests must be applied under exactly similar conditions of temperature, agitation, lapse of time, strength of acid, etc.; and even then, unless the experimenter is well versed in the work, the indications obtained are sometimes perplexing and difficult to interpret. The amount of bromine absorbed by a given weight of linseed oil, or better of the fatty acids obtained from it, affords a valuable test of purity. This amount of bromine is unusually high, much higher than that absorbed in the case of the oils likely to be used as adulterants. But such quantitative determinations can be properly performed only by the skilled chemist. Valenta's acetic acid test is, however, more easily managed. To apply this, take equal volumes, three cubic centimeters of each, of the oil and of glacial acetic acid (specific gravity, 1056·2); mix thoroughly and gradually, heat the mixture until the oil has completely dissolved, or the boiling point is reached. Immerse a thermometer in the liquid, allow it to cool slowly, and note the temperature at which cloudiness appears. The following temperatures are those at which this turbidity is produced in the case of several different oils:

Name of Oil.	Temperature of Turbidity.
Niger seed	49° C.
Linseed	57°
Sesame seed	87°
Almond	110°
Ground nut	112°
Rape seed, mustard seed, etc.	Not dissolved.

It will be seen from these figures that of these six oils that of linseed is, with one exception, the most soluble, and that the presence of such usual impurities as the oils of sesame, rape, and mustard tends to reduce the solubility, and hence to develop turbidity in the acetic acid sooner—that is, at a higher temperature.

The specific gravity of linseed oil also affords a valuable means of testing its purity. At 15·6° C. (60° F.) it is denser than most other vegetable oils.

Name of Oil.	Spe. Grav.	Name of Oil.	Spec. Grav.
Linseed	0·935	Poppy seed	0·926
Gold of pleasure	0·931	Sunflower seed	0·925
Hemp seed	0·930	*Black mustard seed	0·921
*Cotton seed	0·930	*Ground nut	0·918
Walnut	0·929	*Colza seed	0·914

* The four oils marked with an asterisk are non-drying.

Poppy Oil.—This oil is obtained from the seed of the opium poppy, *Papaver somniferum*. It is of a very pale straw color, often almost colorless, and is nearly free from taste and smell. By filtration through hot animal charcoal it may be completely decolorized. If the fluidity of water be represented by 1,000, that of poppy oil at 15·6° C. is 74. Its specific gravity at the same temperature is 0·926. Its chemical composition is near that of linseed oil; it contains the same four glycerides, but in different proportions, for it is mainly made up of linolein and olein. The large quantity present of olein causes poppy oil to be a less rapidly drying oil than linseed. Wolffen, in 1640, stated that poppy oil dries *throughout* in four or five days, while linseed oil forms a pellicle upon the *surface*. Joseph Petitot, writing from Geneva under date January 14, 1644, states that umber is a siccative for poppy oil. Poppy oil was introduced into painting in the beginning of the seventeenth century, after linseed and nut oil. Later on in the same century the Dutch painters acquired greater confidence in this more slowly drying oil, employing it not only in the painting process, but also for grinding their pigments, especially whites, blues, and pale tints.

Nut Oil.—This oil is obtained from the kernels of the common walnut, *Juglans regia*. Leonardo da Vinci directs it to be made from the peeled kernels in order to avoid the chance of darkening its color, and also causing the subsequent alteration of the tone of the pictures painted with it. The kernels were to be soaked in water first, before being peeled and pressed. The introduction of nut oil into painting followed that of linseed oil, and preceded that of poppy. Cold pressed nut oil is much paler in color, and has much less taste and smell than the hot pressed oil; it also differs in composition much in the same way that the cold pressed differs from hot pressed linseed oil. The constituent glycerides of the nut oil are the same in kind as those of linseed oil, but a larger proportion of linolein is present. Nut oil closely resembles linseed oil in its physical characters; its specific gravity, 0·929, is intermediate between that of linseed and poppy oil. Besides the three drying oils already described, we may name that expressed from niger seed, *Guizotea oleifera*. It is occasionally employed in grinding artists' colors as a substitute for linseed and poppy oil. Tea seed and camellia seed oils, and the oils extracted in Japan from the seeds of *Perilla ocymoides* and from the kernels of *Torreya nucifera*, are not of sufficient importance to demand description.

A few observations may now be offered as to (1) the action of certain pigments on oils; (2) the different amounts of oil needed for grinding with different pigments.

1. *Action of Pigments on Oils.*—The most common action is a physical one, in which the opacity of a pigment is gradually lessened in course of time by the more complete interpenetration of the oil between the particles. Thus yellow ocher and raw sienna, for example, darken in color because they become more translucent, just as a piece of oiled cream-laid paper is darker and yellower than the same paper when dry. The light which falls upon it plunges into it more deeply, and on reflection is more highly colored. In the case of such pigments as we have named, and several others, another cause is at work darkening and modifying the color: this is the yellowing of the oil itself. And it is the pigments which require the largest proportion of oil for grinding which exhibit in a marked degree the phenomena in question.

A second action between a pigment and the oil with which it has been ground is the peculiar gelatinous or "livery" condition quickly assumed by some oil paints. This change is particularly noticeable with the cochineal and madder lakes. I have succeeded in obviating it by carefully drying the pigments at a temperature just under 100° C., before grinding them with oil, and by substituting for raw linseed oil a mixture of the "manganese oil," described in the present chapter, with some poppy oil. Those pigments which dry easily should be ground with more of the latter oil, those which dry with difficulty with more of the former. Sometimes pigments harden quickly in the tube itself; this change is due either to the siccative character of the pigments, or to the introduction of an actual "drier," or to the too copious use of a strongly siccative oil with those pigments which are naturally slow in drying.

The third action between a pigment and the oil with which it has been ground is of a distinctively chemical nature. The most striking example of it known occurs with flake white. The lead hydrate in normal lead white saponifies the oil, forming lead soaps with the fatty acid which it contains, and, at the same time, setting free a small quantity of glycerin.

2. The different amounts of oil required by different pigments may now be considered. As a rule, the densest or heaviest pigments require the least oil. A few pigments require an excess of oil in order to protect them from moisture or other injurious agents. Different anthorities do not agree at all closely as to the amount of oil needed to make a workable oil paint from the same pigment. The following list gives the amount required by 100 parts in weight of 19 pigments:

Name of Pigment.	According to M. von Pettenkofer.	According to Winsor & Newton (1882).
White lead	12	15
Zinc white	14	..
Aureolin	..	200
Chrome yellow	19	32
Yellow ocher	75	75
Raw sienna	240	180
Vermilion	25	20
Madder lake	62	125
Terre verte	100	70
Viridian	..	75
Prussian blue	112	75
Cobalt blue	125	75
Ultramarine (artificial)	..	37
Raw umber	..	100
Burnt umber	..	90
Bitumen	..	126
Brown madder	..	87
Burnt sienna	181	195
Bone black	112	110

The great differences in the above amounts of oil do not cause such serious results in the conduct of the process of oil painting as might have been expected at first, for they correspond in a measure to the relative bulks of the several pigments. We can use more copal or amber varnish to balance the excess of oil in some pigments, and so secure a uniformity of structure, texture, and rate of drying in the different parts of the work. It is, however, often convenient to remove some of the excess of oil from a pigment before using it, especially with the colors prepared by some makers.* This can be done by leaving the oil paint on a pad of blotting paper; but 3 in. cubes of plaster of Paris afford a far cleaner and surer method for the absorption of oil. It may be further remarked that the quantities of oil required by some of the pigments in the above table may be reduced by grinding them under greater pressure. Aureolin requires only 80 parts of "manganese oil" for each 100 of dry pigment, instead of 200 of linseed oil, and then yields a quick-drying and perfectly protected paint. Yellow ocher, raw sienna, and ivory black should be dried at 100° C. just before grinding, and then yield workable paints with less oil. The subsidence of vermilion from the oil in which it has been ground may be prevented by using "manganese oil" instead of raw linseed oil, and adding to it a small quantity of hard paraffin wax having a melting point not under 65° C.

SIZING OF PAPER BY MEANS OF ALBUMINATE OF AMMONIA.

ALBUMINATE of ammonia consists of substances that are found in milk and that are used for the same purposes as the gelatine of bones, leather, etc. It possesses the property of dissolving in water without leaving any residuum, and giving a milky liquid. In order to dissolve it, water at 15° C. in sufficient quantity to cover the whole is used. It is allowed to rest for the night. There thus forms a gelatinous mass in which the lumps are easily crushed. The quantity of water necessary to produce a milky liquid, no longer containing lumps and insoluble bodies, is then added. This method of dissolving the albuminate is excellent, and is more advantageous than the one that consists simply in agitating with hot water. Should it happen that, through a prolonged repose, the crust became too hard, a certain quantity of resinous size would be poured upon the latter, and the operation would be continued as above.

The liquor thus obtained is not changed by the addition of resinous size, and starch and the coloring substances employed have no action upon it. The albuminate of ammonia has the greatest resemblance to resinous size. Both are precipitated by the same quantity of sulphate of alumina, and this distinguishes

* Dr. H. Stockmaier, of Nurnberg, has found the following percentages of oil in certain oil paints from different sources which he has analyzed:

Flake white (Roberson & Co.)	16·2
Light red (Winsor & Newton)	41·0
Burnt sienna (Dr. Schoenfeld)	59·2
Chinese ocher (G. B. Moeves)	45·0

them from the other albuminates. All that has been said, as to the sizing by resinous size, may be repeated for sizing by albuminate of ammonia.

The advantages of sizing by the albuminate are rendered evident by the very circumstances of the operation. A complete sizing of the fibers in the pulp strainer is of no value, unless each of them is impregnated with the sizing substance, and that cannot happen unless such substance can circulate through the pores of the fiber and keep within the interior. The structure of the bodies, which, in order to cover the fiber, are precipitated in a thick and regular layer, has likewise a great importance. These bodies are so tenuous that they adhere to one another and then inclose large quantities of water and air, and it is for that reason that the precipitation is very voluminous. Despite that, the fibers still preserve so much suppleness that the felting is not influenced, and the paper thus acquires the greatest strength. In order to fill the interstices of the pulp, it is necessary that the bodies precipitated from the sizing liquor shall have different dimensions, in order that the largest intervals shall be first closed and then tightly closed by the finest portions. Did not that take place, the fine parts would flow off with the water through the large interstices and a loss of the sizing material would result. The solution of resinous size is very suitable for obtaining different dimensions from the precipitated bodies. The bulk of these depends upon the concentration of the liquor. The more dilute the latter is, the finer will be the precipitation. Liquors of less and less concentration must therefore be made to act in succession. These resinous parts, distributed in this way over the surface of the fibers, are so fine that, if the paper be heated upon the drying cylinder, the resin will become soft and combine with the neighboring bodies. Then, if the band of paper be pressed, there will form, after cooling, a hard, impermeable surface, which will prevent ink from penetrating and which produces the strength of the paper.

The sizing matter of milk is employed to more advantage than animal size, because all the albuminates are precipitated by sulphate of alumina. As such precipitation is gelatinous, the distribution is the same through the entire mass and the fiber is covered in a regular manner. The solution of albuminate of ammonia is very fluid, and can consequently be absorbed as well by flax and cotton fibers as by those of cellular tissues.

Sizing with animal glue is too expensive, because the largest part of the gelatine remains in the liquor. With the albuminate, the same is not the case; what is not absorbed covers the surface of the fiber. The solution of resinous size employed up to the present is not capable of penetrating to the interior of the fibers, because in a very short time the pores become clogged and the sizing is superficial only. Nor is it of advantage, either, to employ the albuminate alone, because the latter is precipitated in grains of the same size, while the interstices of the pulp are of different dimensions.

Another advantage of the use of albuminate of ammonia is that melted resin is brittle and that this property is communicated to the fiber. Experiment has shown that the strength, as well as the expansion, of paper is much greater with albuminate alone than with resinous size.

Were the proportion of the quantities of albuminate and resin known, the principal advantage of the process would be patent.

Assuredly, to indicate precise quantities of one or the other is not possible, for the sizing is influenced by the treatment that the fibers have undergone. Yet we can easily find such proportion by means of a few experiments, and the proof of this is seen in the large number of paper mills that are utilizing albuminate of ammonia.

The advantages possessed by paper sized with this albuminate are the following: Greater sureness of sizing, even when the latter presents difficulties; great resistance of the paper, which is brilliant, much stronger, and has a much smoother surface, even under a feeble pressure of the cylinders.—*Moniteur Scientifique, from Dingler's Polytech. Journal.*

A GROUP OF CRITICS.

THE celebrated artist who stands on such a familiar footing with the superhuman world, the mysterious company that throngs the air, and who knows, as few others do, how to depict the emotions of the soul on the human face, has a most decided sympathy with those four-handed ancestors of mankind, the apes. He has studied these creatures carefully, and delights in using them to represent the different dispositions, and even the pain and sorrow, of the so-called "lords of creation," to whom they bear such an uncanny resemblance. But the much discussed picture from which the accompanying cut was taken was not painted simply to represent a number of apes of different species and families huddled together, indicating their characteristic peculiarities; it has a deeper, satirical meaning, for the purpose of the picture is evidently bitter ridicule of the public and its treatment of art, its lack of comprehension, its blind enthusiasm, and its inclination to criticise, blame and find fault with the artist.

All of these moods and impressions of critics examining a work of art are expressed by these baboons and capuchin and other monkeys. The faces of the orang-outangs at the left near the frame and in the dark background of the picture openly express the fierce, angry jealousy of many human critics, dear colleagues of the painter, when examining a much praised picture, but they generally know better how to hide their feelings. The sleek baboon that sits directly in the foreground with his left leg hanging down is very like a well fed member of the exchange and would-be patron of the arts, who pleases himself by playing the role of a connoisseur charmed with what is indisputably a masterpiece, while the face of his companion who is looking over his shoulder expresses utter lack of comprehension and at the same time a certain gloomy perplexity caused by the knowledge of his own incapacity. The monkey with the black face and white beard raises both arms toward heaven and looks as if he were going to clap his hands above his head from delight over the picture; but this enthusiasm rouses the anger of the capuchin that sits in front of him anxiously holding its young one close, so that its curious eyes shall not see anything of the unacceptable and, in fact, dangerous picture. On the frame of the picture is a placard like that placed on pictures sent to exhibitions, with the name of the artist, the subject and the price; the first is hidden by the drapery, but we can read the first word of the title, and that is sufficient to explain the indignation and motherly anxiety of the mother ape. It is "Tristan," and we can easily supply the lacking "and Isolde!"—*Illustrirte Zeitung.*

A GROUP OF CRITICS.—PAINTED BY GABRIEL MAX. (From a photograph by Franz Hanfstangl, A.G., of Munich.)

COLOR PHOTOMETRY.

A LECTURE was recently delivered before the Chemical Society, London, on color photometry, by Captain Abney, C.B., F.R.S. According to the lecturer, the color of a body, when viewed in a light of standard quality, is known when (*a*) its luminosity, (*b*) its hue and (*c*) its purity, or the extent to which it is freed from admixture with white light, are known and expressed by numbers. The luminosity of a color can be given in absolute number by referring it to the standard of white. The standard of white employed is a surface coated with zinc oxide. It is also necessary to employ a standard light in these experiments, and the light recommended is that from the crater of the positive pole of the electric light, or from a petroleum lamp, when the illumination need not be so intense. The luminosity of the pure spectrum colors may be measured by what the author calls the color patch apparatus, which is described in the Phil. Trans., 1886, and in his book on "Color Measurement and Mixture." The luminosity of a color is not the same when viewed from all parts of the eye. The luminosity of any pigment on paper can be found by rotating it with two or three colors, red, emerald green and ultramarine. The color of a pigment can be referred to the spectrum colors by measuring the absorption. The mixture, in varying proportions of red, green and violet of the spectrum, makes white. Any other color can be matched by the mixture of the same three colors. Since three colors will make white, and the same three colors will make a match with an impure color, every color in nature can evidently be matched by mixing not more than two of these colors with a certain proportion of white light, and if these colors be red and green, or green and violet, the color can be matched by one spectrum color and white light, since there is some intermediate color which has the same hue as the mixture of these

two colors. Hence any color may be expressed in terms of white light and one spectrum color, the latter in wave lengths and the former in percentage of luminosity. The lecturer performed experiments in illustration of all the points brought forward. The importance of using some uniform light was insisted upon throughout. In conclusion the lecturer claims to have demonstrated that the reference of colors to numbers is not only possible but easy.

SPORT ON THE "SKI" IN NORWAY.

JAMES SMART, the champion skater of England and Holland, together with Messrs. C. G. Tebbutt and T. C. Aveling, were most hospitably entertained at Christiania, Norway, previously to their departure for Hull, by Hagen, Smart's rival competitor in the skating contest at Hamar, and other Norwegian sportsmen, who arranged a meeting of some of the best "Ski" (snowshoe) men at Frogner Sætre, on the heights near the city, in order to give the visitors an idea of how the Norsemen can skim down the slopes on "Ski," and clear a leap in their descent. Unfortunately the snow was somewhat soft, so that the longest jump was only about 45 ft. Under favorable conditions distances of 70 ft. and upward have been cleared in one bound. But, nevertheless, the Englishmen got a good idea of what may be done, and Mr. Tebbutt himself, on his new "Ski," dared the descent and got down in safety, though in a style peculiar to novices. The "Ski" are formed of wood about 8 ft. in length by 3 to 4 inches in width, turned up at the toes, and are attached to the foot by bands of withes or leather straps. On them it is possible to proceed at considerable speed over the softest snow, while the pace attained on gliding down a slope is practically unlimited. Coasting, which consists of sliding down the roads on a sled, steered by a long pole, also a favorite pastime, was witnessed by the visitors, but not attempted by them. Among other things connected with Norwegian sport, the British skaters were shown figure skates, each formed by hand out of one steel ingot; snow skates for use on the highways—long wooden runners shod with iron; while they are carrying home with them several pairs of the 18 in. long knife blade racing skates, which will probably ere long be adopted by all speed skaters throughout the world. It is odd that but few Englishmen as yet understand that Christiania is within easy distance of England—some forty-eight hours' steaming, in fact—and that there every kind of winter sport may be indulged in with comfort for several months of the year. It is, however, to be hoped that ere long Christiania may be regarded as one of the centers of such pastimes, and be visited by many of our countrymen. It may be mentioned that the great "Ski" competition of the country will probably be held during the first week in February. It is a sight worth traveling any distance to see.—*Daily Graphic.*

WARM WORK FOR WINTRY DAYS—A NORWEGIAN "SKI" JUMPING MATCH—IN MID-CAREER. (From an instantaneous photograph.)

A SKUNK FARM.

PROBABLY no one of our wild North American animals has lived in such constant disrepute since the day of his discovery by white men as the skunk. Not only is he looked upon as a robber of hen houses, but for certain urgent reasons he is always given a wide berth by man and beast alike. Many cannot even think of a skunk without strong feelings of disgust. His name even is against him, and can hardly be mentioned in polite society. It is no wonder that the skunk is mercilessly slaughtered whenever it can be done with safety, his really valuable fur being often a secondary consideration, and in consequence he is now only seldom found in a wild state—in the settled portions of New York State, at least. This much maligned animal hardly deserves to be regarded with such universal antipathy. He possesses a gentle, docile disposition, and is seldom disposed to flee at the approach of man.

Many anecdotes are related of persons who have mistaken the animal for a cat on account of the darkness or their ignorance. Unpleasant consequences have followed their handling and petting the supposed cat only after the animal had received real or fancied abuse. There is, however, a close connection between the gentle and peace-loving disposition of the skunk and the efficient method of defense that nature has provided for him. In a formation of glands peculiar to the skunk a yellowish liquid is secreted. This powerful, pungent, and nauseous fluid can be thrown a distance of six or eight feet toward the offensive object. Books upon natural history are not agreed as to the number of distinct varieties in the skunk family.

A number are found in the Southern States and some range into South America. The common black, or black and white, is the one with which we have to do at present; it ranges from the Hudson Bay on the north into Central America on the south. The skins which bring the highest price in market are the coal black kind.

The black skunk could hardly be classed as a distinct variety; it is a sport perhaps from the striped. In their native haunts the blacks are a rarity, but skunk farmers by breeding carefully can perpetuate them. They are entirely of a sable hue, with the exception of a tuft of white on the top of the head. The possibility of producing black skins, together with the lucrative prices they bring, has led a number of persons in different parts of the country to attempt breeding skunks in captivity. In this, as in all other legitimate enterprises, success depends upon a thorough knowledge of the business. Experience is the principal teacher, there being but little data to draw from, and much of the work has been decidedly up hill.

It is perhaps on account of the difficulties surmounted that breeders of skunks are somewhat reluctant to part with the knowledge they have acquired with so much difficulty; but there is but little danger of an over-supply of fine quality pelts, as the nature of the business will naturally deter many from going into it, while the skunk in its wild state is doomed to gradual extinction.

One of the pioneers in the skunk breeding industry is Mr. Henry Gurnsey, of Lima, N. Y. Mr. Gurnsey has been for a number of years a dealer in skunk and other furs, and about six years ago determined to attempt the breeding of skunks in confinement. He first inclosed a portion of his back yard by a tight board fence, and sank planks in the ground below the fence. Then he trapped or bought a few pairs of skunks, and placed them in the inclosure. The experiment was a success from the first. The skunks increased so rapidly as to become at length somewhat of a nuisance within the corporate limits of a village, and Mr. Gurnsey decided to remove them to some point in the country where he could engage in skunk farming on a scale worthy of the name. He found a suitable location about three miles east of Lima village, and formed a partnership with Mr. W. Shaddack, who owns a part of the land now occupied by the farm and who assists in caring for the animals.

About five acres were inclosed. A trench was dug in line with the proposed fence, and planks were sunk in it a depth of two feet; then it was filled in on both sides of the fence with small stones, which were covered with earth. The part of the fence above ground is tight and four feet high. On a recent visit to this farm a faint but characteristic odor warned us of the proximity of the "ranch." On arriving, it became evident at once that a steep sidehill, underlaid by a tenacious clay subsoil and which would be worthless for other purposes, is the proper thing for skunk breeding. It is only on steep land that the burrows can be made with ease, and all of them have good drainage. The hill rises to a height of perhaps 150 feet above the road which runs along the base.

The face of this incline is honeycombed all over its surface by hundreds of skunks' "nests," but during the greater part of the day a casual passer-by will see little of interest within the inclosure at any season. Only occasionally will a skunk, driven out by hunger, make its way to a portion of some freshly slaughtered animal that has been placed there for food. But about 6 p. m. on summer days, and somewhat earlier in the spring and fall, the colony begins to show signs of activity, black heads appear, then bodies emerge and make their way down zigzag paths of their own making toward the point where food is placed; from this time on during a considerable portion of the night the hillside may be said to be literally alive with skunks.

The question of obtaining food for them is the all-absorbing one with the proprietors of the ranch. During the woodchuck season they are out day after day scouring the country for these animals, and other hunters are also kept busy. But woodchucks, coons, and other small game are not found in sufficient numbers, and a large supply of meat is obtained in the shape of domestic animals which have outlived their period of usefulness, or have met an untimely death. The wants of the skunk breeders are pretty well known all through this section of country, and they are often summoned by telephone, letter, or verbally to go and relieve a man of a decrepit horse, a dead cow, or abandoned sheep. When the supply of meat becomes too great for immediate use, it is cut from the carcasses and salted down in barrels in the cellar of one of the buildings which are attached to the ranch. Later on this meat is taken up and boiled in a large caldron, meal is added, and the mixture, as well as water for drinking, is placed in a series of troughs along the base of the hill. As skunks become semi-dormant, they consume but little food during the coldest parts of winter. In spring and fall, carcasses are left out for several days until consumed. As this cannot be done in hot weather, the cooked ration is fed largely. The skunks breed in early spring, eight or ten making a litter. By fall the young ones are full-grown, and cannot be told from the old. Overfeeding must be guarded against, as it reduces the size of the litter.

Recently I visited the farm during the annual killing, which begins about December 1. Six or eight men were at work on the steep hillside digging out the skunks, which are placed in sacks held by helpers. These holes or nests are made by the proprietors with spade and shovel, by digging downward into the bank for three or four feet. As it is hard to dig under it without causing it to cave, an earth roof is not generally made; instead, the large cavity is nearly covered with rails and boards, and dirt is thrown over.

Skunks burrow but little, and in a wild state appropriate the holes of woodchucks and other burrowing animals. New holes are made as fast as the colony seems to require them. There is no regularity as to the number inhabiting a hole; not less than two or three were found, but in some cases 15 or 20 had crowded together in one hole.

The males also were found collected in one portion of the grounds. At the "skunk harvest" the roofs are thrown off the holes, and a little digging brings out all that are inside. When a bag is filled, the man throws it over his shoulder and carries it down to the skinning room. Here the animals are sorted. The best marked are saved for breeding, one in ten being a male. They will be kept in the building until all have been dug out, when they are turned into the inclosure. Those to be killed are taken outside and dispatched by a blow on the head, and skinned as soon as dead. Only rarely do they throw scent at this operation. The skins are hung up to dry with the flesh side out. The building contained many fox, coon, and muskrat skins, besides hundreds of skunk pelts. The output of the ranch will be about 800 skins this year, as many live skunks will be kept for the next year's breeding. Before the carcasses are removed, after skinning, the fat is cut off and tried into oil. Good black skins are worth in the neighborhood of $1.50 each.—*Arthur D. Warner, in Rural New-Yorker.*

GOLD QUARTZ REDUCTION.

AT a recent meeting of the Institution of Civil Engineers the paper read was "On Gold Quartz Reduction," by Mr. A. H. Curtis, B.A., Assoc. M. Inst. C.E.

The author reviewed the principal crushing and pulverizing machines employed in the reduction of gold quartz, considering that term to include all auriferous silicious rocks, from true quartz to conglomerates such as the "banket" of Witwatersrand. Many of the machines were equally applicable to the treatment of other ores. The author described the more important crushing and pulverizing machines.

1. *Ore Crushers, or Rock Breakers.*—These are used for the preliminary coarse crushing of quartz, and were subdivided into: (*a*) Machines on the reciprocating jaw principle, including the Blake and Dodge varieties; (*b*) gyratory crushers, as the Comet crusher and the Gates rock and ore breaker.

2. *Crushing Rolls.*—These were considered under three heads: (*a*) Cornish rolls, with lever and weight compression; (*b*) improved Cornish rolls, with steel buffer springs or India rubber buffer cushions, possess-

ing many merits, but having smaller capacity and durability than jaw or gyratory crushers, which were, therefore, preferred for coarse crushing; (*c*) Krom's rolls possessed great strength and durability, and were capable of much finer crushing than Cornish rolls.

3. *Stamps.*—These are fine pulverizers. The varieties described were: (*a*) Gravitation stamps, which are lifted by rotating cams and fall by their own weight; (*b*) special forms of stamps, including oscillating, pneumatic, steam, elephant, and other varieties.

The merits and defects of gravitation stamps were discussed at considerable length, and a description given of Husband's and Sholl's pneumatic stamps, the steam stamp, the elephant stamp, and the Huntington mill.

4. *Roller and Edge Runner Mills.*—Two varieties were considered: (*a*) The Bryan roller quartz mill, in which three metal rollers revolve in a circular pan or mortar, the arrangement somewhat resembling the Chilian mill. Mercury was placed in the pan for amalgamation. (*b*) Huntington's centrifugal roller quartz mill. Three or four rollers, suspended from a rotating circular frame or "disk driver," were urged outward by centrifugal force to a circular steel ring die, against which the ore was pulverized. Mercury for amalgamation was placed at the bottom of the mill, the rollers being so suspended as to pass freely over it, without coming in contact with it and stirring it up. Paxman's patent roller head, an improvement on the older construction, was described. The mill was recommended by the author for clayey quartzes—which required a certain amount of puddling before the gold was liberated—for quartzes of medium hardness, and for grinding coarse tailings.

5. *Ball Pulverizers.*—In these machines, coarsely crushed ore, or coarse tailings, were pulverized by a ball, or balls, of chilled iron, steel, or other durable metal revolving on a circular track or path. This grinding path may be vertical or horizontal, preferably the latter. Several varieties were described.

6. *Pneumatic Pulverizers.*—Contrivances in which small fragments or coarse particles of ore are hurled against each other by the action of two opposing currents of air, or in some other manner, with such force as to cause them to be finely pulverized. The author described the principal machines of this kind, and pointed out that the high speed at which they generally required to be driven was a decided disadvantage, entailing an excessive amount of driving power.

7. *Miscellaneous Grinders or Pulverizers.*—Under this head were described (*a*) the Niagara mill, in which the ore was pulverized by a heavy edge runner, contained in a metal drum rotating on a hollow horizontal axis, through which the ore was exhausted by a fan as soon as it was sufficiently finely comminuted. (*b*) The Howland pulverizer, consisting of a circular pan in which the ore was granulated against a steel ring die by twelve disks or rolls, which lay on a horizontal carrier plate, rotated by bevel gearing. The rolls were urged outward to the ring die by centrifugal force, and rotated against it by friction.

8. *Grinding and Amalgamating Pans.*—These are used for grinding to minute particles ore already more or less finely reduced by other machines, and subjected to subsequent concentration; and, secondly, to effect an amalgamation of the gold contained in the pulp with mercury introduced into the pan. The numerous varieties of grinding pans were briefly referred to, but did not call for any special criticism.

COSTA RICA'S COFFEE CULTURE.

COSTA RICA is one of the five Central American republics. It is bounded on the northeast by the future Nicaragua Canal, on the southeast by the United States of Colombia, on the northeast by the Atlantic Ocean, and by the Pacific Ocean on the southwest.

The area of the country is 37,000 square miles, and its population was, in 1890, 216,756 inhabitants. Now about 300,000 are calculated. Costa Rica has the most delightful and favorable climate, not only for the growth of coffee, but for every kind of culture. Its temperature through the year is from 65° to 70° Fah.

The country may be divided, according to its climate, into three different zones:

I. The "hot zone," running from the sea level to the altitude of 3,000 ft., where most of the virgin forests are found. It is the hottest in the country. The mean temperature is from 72° to 82° Fah.

II. The "temperate zone," in which agriculture is chiefly practiced and which may be regarded as the center of population and commerce.

III. The "cold zone," 6,000 ft. of altitude, where the thermometer sometimes falls below freezing point.

Properly speaking, there are but two seasons, summer, or dry season, and winter, or wet season. The former is from November to April or May, and it differs from the latter by the absence of rainfall.

Coffee plantations are chiefly cultivated in the vicinity of the capital, San José (altitude 3,711 ft. above the sea level), in the provinces of Cartago (4,633 ft.), Heredia (3,655 ft.), and Alajuela (2,950 ft.)

The largest coffee plantations are to be found in Heredia and in Santo Domingo. Nature seems to have particularly favored the lands of Costa Rica. There are indeed few countries in either continent possessing so much fertile soil as this small republic.

A single fact among hundreds may prove this statement. The first coffee seeds sown a century ago in the province of Cartago were introduced from Havana; the old trunks from which seeds were distributed to the other Central American republics are seen yet, and as the writer was told, they are producing perhaps as much fruit as when they were young. Meanwhile, in Brazil 50 to 60 year old trees are seen as a curiosity.

Mr. Biolley, in his very interesting work on "Costa Rica and her Future" (Judd & Detweiler, Washington, D. C., 1889), says:

"Almost everywhere in Costa Rica the land is found to have most favorable conditions for recompensing labor, admirably watered by streams, often navigable, and wooded with species of the most valuable and useful trees.

"The alluvial lands of ferruginous clay and silico-argillaceous lands predominate. All over the central plateau the vegetable stratum is of a remarkable depth."

COFFEE PLANT.

Coffee Arabica is the species grown in Costa Rica. There is also the "Grecia" coffee, but it is not very much cultivated. It is found in the northeast part of the central plateau. This shrub is shorter than the precedent, and its branches are somewhat more compact and numerous than the former.

Some years since "Liberia" coffee was introduced, and its cultivation seems to extend throughout the republic.

When the shrub (Coffee Arabica) is four years old it has reached the full amount of production. Then it is from 6 to 8 ft. high. It blossoms in April or May, and if it should rain when the flowers have "set," a shower will be of great benefit for the future crop. Irrigation is sometimes practiced when the season is too dry. Very good results have been obtained by watering the plantation artificially.

The berry, in the first days of its existence, is of a dark green color, changing to a yellow red, and finally to crimson.

When the berries have become crimson they are then quite ripe, and harvesting must begin, else the berries will turn black. The external envelope will contract on itself and the fruit fall to the ground.

PLANTING—NURSERY BEDS—SPACES.

Every one knows that coffee is propagated by seeds. For that purpose a space is chosen in the same plantation, varying in size according to the number of seedlings wanted.

When the soil has been loosened and cultivated and cleared from weeds, stones, etc., the seeding is done, covered with soil enough to cover the seeds. Leaves are spread on that piece of ground, which will act as mulch to hinder the evaporation of water and to keep the soil as moist and cool as possible, so that the seedling will start freely.

During the first year of the young plant's growth, great care must be given to it. Weeds are not allowed to grow, lest they should become, in a short time, larger than the coffee plant, and would hinder its development.

At the end of the year or before, they are transplanted to their permanent place in the estate or are sold. In the former case, the holes are dug to receive the young plants. When these are removed from the nursery bed, some earth is left around the roots, and this ball of earth is covered with banana skins, to keep it moist. The same thing is done when the plants are to be sold.

The space left between the shrubs varies somewhat. Generally, they are left 10 ft. apart, so that 400 to 435 trees cover an acre of land.

CULTURE.

As has been said, weeds grow very rapidly, because of the great fertility of the country. So a great deal of labor is needed to keep the gardens free from weeds. The weeding is done by hand labor. Each workman is provided with a large sharp shovel, with which he cuts down the weeds, taking some loose earth and heaping it around the trunk to form low ridges. The earth serves to cover the weeds and haste their decomposition. This operation is called in the country "aporca," and it is done from May to June. During the winter months the operation is reversed. The ridges, built up in summer, are now spread out between the rows of coffee. This operation is called "desaporca." Again, the "aporca" is done before harvesting, in order to have the ground clean and to facilitate the picking up of the berries that fall down during the harvesting.

Finally, the "desaporca" comes again after the crop has been harvested. Once a year, as a general rule, the plantation is plowed, but only on one side of the rows; the other side of the row being left for the plowing in the next year.

Some writers have, perhaps, exaggerated in saying that the cultivation of coffee suffers *very much* in Costa Rica from the want of labor. This assertion may be true to some extent, and immigration is doubtless very much required for the prosperity of the country, not only in respect to agriculture, but to other forms of industry.

MANURE.

The fertility of the estate is kept up in different ways.

In weeding, the furrows are not only made for the sake of covering the weeds, but also to prevent the washing of the surface soil. Holes, that are 3 to 4 ft. square, are dug between every four or more trees. These holes are left open. So that when it rains the alluvial soil, which would otherwise be washed away when sloped, is retained. When they have become filled up, the contents are spread around the shrubs.

Among the natural fertilizers, green manure may be cited. Farm yard manure is very much employed, producing very good results. Composts of pulp, husk, banana skins, and all the refuse from the curing of the coffee serves as fertilizant materials.

If we regard irrigation as a fertilizer, it should be mentioned in this classification. Irrigating water is sometimes mixed with pulp, and with the "honey" of the coffee.

Some planters import Peruvian guano, recognizing its great merits as a coffee fertilizer. It is applied in most cases in circular ditches, dug at 9 or 10 in. distance from the trunk of the trees to a depth of 3 to 4 in.; 4 to 6 ounces of guano are spread in each ditch, and covered with the soil which was taken from it.

To fertilize an acre of land, 125 to 150 lb. of Peruvian guano are needed, as the coffee gardens are not manured every year with guano. Some planters are accustomed to apply it twice a year.

SHADE.

In order to prevent the coffee flowers from being damaged by the sun's rays, experience has proved that the coffee tree should not be left without shade. For that purpose banana trees are planted between each third or fourth row of coffee trees. Besides bananas, many other trees are planted which, with their large branches, cover much ground. Several species of acacia have proved to be beneficial in the plantations of coffee or "cafetales." Poró, juiquiniquil, etc., are grown among the shrubs, and some of them bear excellent fruit crops.

PRUNING

is performed in order to let air and light circulate freely among the trees, to facilitate their development and to obtain the largest possible crop. Not every planter in Costa Rica is agreed as to the best method of pruning. Some of them think that no branches other than those which are dead should be cut off. While the majority know that great benefits may be derived from a judicious pruning, and that the future crop may be vastly increased. The latter not only cut off the dead branches, but also those that appear to be half dead. When the suckers become numerous a part are cut off. When the trees are five or six feet high they are "topped," to prevent them from growing out of reach. This operation is performed by pinching off the two new leaves which form the top of the tree. When the "top" is destroyed, the shrub tends to throw out side branches, and remains at such a height that the gathering of the fruit is facilitated. Finally, the tree is "handled" after each crop to remove the dry wood, vegetal mosses and parasites, and also to prepare it for the next year's crop.

DISEASES AND ENEMIES.

Few or no diseases are known in Costa Rican coffee plantations. Isolated cases have been reported where the leaves become brownish and soon after fall down. This disease is caused by a fungus known as "Depazea maculosa of Berkeley," and the disease itself is called "Mancha de hierro." Among the enemies are the Clusia insignis, called in the republic "matapalo," which must be carefully destroyed, for it would kill the shrubs. The others are vegetable mosses, lichens, weeds, etc.

HARVEST.

It has been calculated that, in 1890, on 8,130 coffee estates there were 26,558,251 coffee shrubs. Each tree produces from 1 to 2 lb., not infrequently 5 or 6 lb., of coffee in "oro," that is to say, ready for market.

Harvesting begins as soon as the cherries are quite ripe, usually from November to February. Sometimes the berries do not ripen all together, in which event, a second harvest is needed.

The gathering of the coffee is done by men, women, and children. To each one a basket of the capacity of fifteen to eighteen quarts is given. I have seen myself coffee pickers to fill their basket from ten to twelve times a day if the crop is good, and to get for each basketful ten to thirty cents, so that coffee gathering may produce to them from one dollar to over three. In payment, money is not given, but "tokens" which represent the value above stated. On Saturday evening or Sunday morning these tokens are changed to current money.

The harvesting is performed methodically. A man who takes care of the crop assigns to the "cafeteros" those trees which must be picked first. The pickers cannot change from place as they would like until they have picked the trees designated by the "mandador," the man in charge.

In the evening, an ox cart is driven to the places where the picking is going on, in order to get the coffee which has been gathered during the day.

PREPARATION OF THE BERRIES.

As soon as all the coffee has been "entregado," it is carted immediately to the factory and thrown into a brick tank which is larger or smaller according to the size of the plantation. It is made large enough to hold as much coffee as can be picked in a day. Water enough is run in to thoroughly cover the berries, which are allowed to soak for a short time, then from this first tank the berries are conveyed to the pulper through a channel, by means of water.

PULPING

consists in the separation of the beans from the pulp in which they were enveloped, by means of the "pulper," which is a machine composed of an iron cylinder covered by a sheet of copper, having its surface toothed. At a convenient distance from this cylinder there is a piece of iron, placed in such a way that no bean can pass through this part of the machine and the cylinder without being squeezed. The bruised beans pass through the teeth of the machine, while the pulp falls to one side. The pulp is carefully gathered and piled up in heaps, where *it ferments*. Finally, it is utilized as a manure for coffee and sugar cane.

The beans coming from the pulper are covered by a parchment-like membrane and saccharine matter. If these are not removed from the berries, they will dry easily or rot. For this reason a special fermentation is needed.

FERMENTATION.

From the pulper, water conveys the husked beans to a tank filled with water. During the whole time the beans remain in this tank they are frequently agitated with wooden rakes, to wash out the saccharine matter and any pieces of pulp that may have escaped the action of the pulper.

The light berries, together with pieces of pulp, leaves, etc., float upon the surface and are skimmed off, while the good berries remain at the bottom of the tank.

This tank is made of brick and cement; it has at its lowest part a sluice door, from which, by means of cars or channels, coffee is carried to the drying floors or "patios." The patios are generally square, flat, built of rammed stone and cemented at the surface. These are made to slope slightly, so that water may drain away.

DRYING

is one of the most important operations in the preparation of coffee, because, if it were allowed to become too dry, it would lose weight and contract upon itself and present a non-attractive appearance. If too wet, the coffee would become mouldy and be spoiled.

The beans coming from the tank are spread on the "patios" to a depth of two to three inches, and are left there drying, but are constantly turned over with light rakes into rows, in order that the drying be slow. The time of drying depends on the weather. If it rains, the beans are heaped and covered with canvas. When the beans are perfectly dry, as is known by the fact that they cannot be dented with the finger nail, and that they crack between the teeth instead of tearing, they are fit to be stored or peeled.

PEELING OR HULLING

has for its object the removal of the parchment skin that is still adherent to the dry bean.

To perform this operation, the beans are thrown in

to a circular basin with a broad channel or groove. Two or more wooden or stone wheels, moved by oxen or by water power, run in this circular groove, which has been filled half or three-quarters full with dry beans.

In the center of the basin, or "trilla," an axis is fastened to the ground. From this two or more horizontal bars serve to move the wheels, which are kept running until all the dry beans have been separated from their parchment cover.

From the "trilla," coffee husks and dust are put into bags and thrown into a winnowing machine. The husks are blown out by the current of air, while the coffee falling down passes through different sieves. The uppermost sieves have round holes, which allow the sand, smaller beans and stones to pass through, while the larger beans are retained. The second sieve has holes small enough to permit the sand and very small gravel to get through, but not the perfect coffee beans, which fall by the front part of the machine, where they are bagged. The dust takes another way, passing free from any bean, through one of the sides of the fan.

There is yet another skin, called "silver skin," that must be removed. The operation is the same as for peeling, but with lighter wooden wheels.

This old fashion of removing the silver skin by means of wheels has been changed by a machine composed of two cylinders, having their surface roughened and moving in a contrary direction, the results being better and economy of labor.

The coffee, as it comes from this machine, goes to the "pulidor," for it needs to be separated into various sizes for market.

The machine which performs this classification is called "clasificador."

It is composed of a long horizontal cylindrical sieve formed of galvanized or steel wire divided into sections of different meshes. A very strong brush of the same length, but smaller, lies against and turns with the cylindrical sieve, so as to prevent the coffee from choking the meshes.

The "clasificador" is run by hand or by hydraulic power.

In the first section, the sand and dust fall down, in the next the small and broken beans, in the third large beans, while in the last the largest beans are delivered. The so-called "pea berry" rolls freely in each section till it gets to the end of the sieve, where it falls down.

The coffee from each division is gathered apart and forms the 1st, 2d, and 3d classes, and pea berry or "caracolillo."

After this mechanical sorting, coffee passes through women's hands, who pick up and separate small stones, light coffee, foreign seeds, etc.

This work is done on tables made specially for this purpose, "sorting tables." The coffee coming from those tables is ready and bagged in sacks containing about 130 lb. each and shipped.

STATISTICS.

The exportation of coffee in the following years was:

In 1886 Costa Rica exported	19,931,214	lb. value in	$2,259,263
" 1887 "	28,852,177	"	5,231,766
" 1888 "	22,745,502	"	4,742,253
" 1890 "	33,924,675	"	9,196,202
Total amount of	105,453,568		$21,429,484

The crop of the year 1888 was distributed between the following countries:

England	13,507,818	lb. value in	$2,859,896
United States	6,862,367	"	1,395,920
Germany	1,304.860	"	279,763
France	860,575	"	165,002
South America	209,882	"	41,672
	22,745,502		$4,742,253

In 1887, 284,454 lb. of coffee having a value of $51,590 were exported from Costa Rica to Boston. The average price was a little over 18 cents a pound; while in London market, Costa Rican coffee sells at 92 to 130 shillings the hundredweight; meanwhile the best Javan costs only 90 to 100 shillings; the Mexican, 65 to 84 shillings.

Costa Rica's coffee is said to be unsurpassed in strength as well as in aromatic flavor by the eastern growths. Its preparation is so good that it competes in the English market with that of Java, Molucca and with the best known grades.

What better proof can we have of the goodness and superiority of Costa Rica coffee than the fact that in the Paris Universal Exhibition of 1889 it obtained the "Grand Prix"? FEDERICO PERALTA.

Boston, January 6, 1892.

MOTIONS OF THE HEAVENLY BODIES.

IT is generally thought by astronomers to-day that all the celestial phenomena within reach of human vision belong to a single great system; but it is not yet possible to say just what the controlling order in the motions of the stars composing the visible universe is. Observation shows that all the stars are in motion, but with varying velocities, and in all possible directions. In the same quarter of the sky, and even in comparatively crowded aggregations of stars, some are found to be moving in one direction and some in another. In the case of the well-known figure of the Great Dipper, for instance, the motions of the stars are such that in the course of some thousands of years that figure will cease to be remarked in the sky. Many of its stars will have separated, going in several directions, although some of them will continue to keep company, as their journey lies the same way in space. So, too, some of the stars are approaching us and some are receding from us. The spectroscope, aided by photography, enables astronomers to measure the velocity of these flying suns that are either coming nearer to us or passing further from us, with an accuracy that takes account of a single mile per second. The sun is not exempt from this universal law of motion. It is speeding at the rate of several hundred millions of miles in a year toward a point in the northern heavens situated not far from the brilliant star Vega, a sun that is vastly more luminous than our own. So we on the earth are not traveling, as most persons imagine, in a beaten track around the sun year after year, but the earth follows the sun in its northward-pointed course, and consequently sweeps onward in vast spirals around the moving sun, so that we are continually borne into new regions of space.

The extension of the law of gravitation throughout the universe has been questioned, but never very seriously, and every fresh investigation of stellar motion strengthens the belief that that law really governs the whole visible celestial system. In the case of the binary stars, of which a great number are known, the revolution of the two stars around one another or around their common center evidently takes place in obedience to that law. Now, if gravitation extends throughout the universe, no star can escape from the attractive influence of every other star, and of all the other stars. So gravitation in itself forms, as it were, a system of links or chains binding the stellar system together. If we can ascertain the distance and the mass of any star in the heavens, it is a simple problem to determine just how much the force of that star's attraction upon our sun is. But when an attempt is made to apply this general principle to an investigation of the actual motions observed among the stars, almost insuperable difficulties are encountered. Those motions occur in so many different directions and with such various velocities, and our knowledge of the actual distances of the stars from us and from one another, and of their actual masses, is so fragmentary and incomplete, that no systematic order, betraying a grand center, or a universal law, controlling the gyrations of the celestial bodies, becomes apparent from their examination.

More than once it has been imagined that the great center of motion in the universe has been discovered or located. Many years ago Madler thought that the Pleiades were the center around which our sun was moving, and the beautiful star Alcyone became widely celebrated as the great central sun. But it was all imagination. Later investigations showed that Madler was mistaken, and now astronomers are not even prepared to say in what direction the center of the sun's motion lies, or, indeed, whether it is not at present actually flying ahead in a straight line. So speculations on a genal rotation of the Milky Way, that vast irregular stellar ring, which girdles the visible heavens like a belt, and contains within its borders the majority of all the stars, have generally been abandoned in face of the fact that no common motion of its component stars can be detected.

Yet no astronomer doubts that there is a general law governing the maze of motion which we behold about us. The fact seems to be that there are many centers of motion, as the tendency of the stars to aggregate in streams and clusters indicates, but the precise relation of these aggregations to one another has not yet been made out.

The problem is complicated by the fact that some stars are known to be moving, apparently in straight lines, with velocity so great that the combined attraction of the whole known universe would not have sufficed to have set them going as they are. Nor can the astronomer foresee what the future career of such stars will be after they have passed out of the stellar system, as they seem destined to do. Are there invisible systems beyond our starry swarm from which they have come or to which they are returning?

Yet, however difficult it may be to account for the observed motions of the stars, it is impossible to resist the conclusion that everything that we see in the heavens forms part of a single system. The idea that some of the faint nebulous specks, glimpsed here and there, may be outer systems far beyond the confines of our own stellar universe, has been abandoned since the spectroscope has shown that the misty patches of light, which even Lord Rosse's giant telescope could not resolve into stars, are really masses of matter in a gaseous condition, and not, as was formerly supposed, congregations of stars so remote that the utmost magnification could not disentangle their mingled beams. The very variety which we behold in the universe shows so clearly the operation of systematic forces of development that it serves as an argument in favor of the view that all we see are only different parts of a single system.

Elements that exist in the earth are detected glowing in the atmospheres of stars in all quarters, but the same instrument which reveals the presence of these elements discovers also the fact that the bodies constituted of them are in various stages of development. Our sun represents only one type of a solar body, and its condition is not permanent and unchangeable. In Sirius and Vega we behold suns which are evidently glowing with a far fiercer energy and a much greater intensity of radiation than our sun exhibits at present. But we may go a step further back than that which Sirius or any star represents, and perceive in the whirling spirals of the Andromeda nebula, and in the vast streams and condensing aggregations of the Orion nebula, evidence of the formation of stellar centers out of elemental chaotic clouds through a process that is going on now, and, so to speak, under our eyes. It is indeed a living universe which includes the earth that we inhabit.—*N. Y. Sun.*

THE RELATIVE BRIGHTNESS OF THE PLANETS.

By J. E. GORE, F.R.A.S.

THAT the planets shine with very different degrees of brightness is a fact familiar, perhaps, to most people. The great brilliancy of Venus, when favorably situated as a morning or evening star, is well known, and has frequently given rise to the erroneous idea that a new celestial visitor had appeared in the sky. Jupiter, when in opposition to the sun and high in the heavens, as it is in some years, also forms a brilliant object in our midnight sky, and it is closely rivaled in luster by the "red planet" Mars, when nearest to the earth, as it will be in the autumn of the present year. The difficulty of detecting the planet Mercury with the naked eye, owing to its proximity to the sun, is well known. When seen, however, under favorable conditions, this planet shines with considerable brilliancy, but, as it can only be seen at its brightest for a few days in the morning or evening sky a little before sunrise or a little after sunset, and then only for a comparatively few minutes in the twilight, it generally escapes the observation of the casual observer. The "ringed planet" Saturn usually appears brighter than an average star of the first magnitude, and may be easily distinguished by its dull yellow color. The light of this planet is of course considerably increased when the ring system is widely open, the bright rings being very luminous; but, when the rings are nearly invisible, as they are at present, the brightness of Saturn is much reduced. Uranus is just visible to the naked eye on a clear night, when its exact position with reference to neighboring stars is known, but Neptune is quite beyond the range of unaided vision.

These differences in the relative brightness of the planets are due to four causes: (1) The distance of a planet from the sun; (2) the distance of the planet from the earth; (3) the size of the planet; and (4) the reflecting power of its surface, or the "albedo." Of these the first three are easily determined by observation, and a simple method of computing the relative albedos of the different planets forms the subject of the present paper.

The method of computation is as follows. The brightness of two planets will vary inversely as the square of their distance from the sun, and *directly* as the size of the planets' disks as seen from the earth, or, making due correction for their crescent and gibbous forms, as the square of their apparent diameters measured in seconds of arc. The results of this calculation will represent the relative brightness the two planets should have if both had the same albedo. If, however, one of them appears brighter than calculation indicates, it implies that its reflecting power or albedo is greater than the albedo of the other. As the relative apparent brightness can be measured with a photometer, we have all the necessary data for calculation of the relative albedos.

The albedo is generally represented as a decimal fraction. This fraction denotes the proportion of light reflected compared with the amount received; the albedo of a surface reflecting *all* the light which falls upon it would be represented by unity. Probably, however, no such surface exists, the albedo of even freshly fallen snow being less than unity.

The difference of albedo in the planets is in some cases very striking. In 1878, when Mercury and Venus were in the same field of view of the telescope, Nasmyth found that Venus was at least twice as bright as Mercury. He compared Venus to clear silver and Mercury to lead or zinc. From photometric observations by Pickering and Zollner, the brightness of Venus is nearly as great as if its surface was covered with snow, and Zollner found that the surface of Mercury is comparable with that of the moon, which has a small albedo. This difference of surface brightness is very remarkable when we consider that Mercury is much nearer to the sun than Venus. If we suppose that the surface of Venus is covered with a cloudy canopy, as has been suggested, this cloudy covering would perhaps account for the planet's great reflecting power.

Owing to the uncertainty which exists as to the relative apparent brightness of Venus and Mercury as viewed with the naked eye, it is not easy to compute correctly their relative albedos. Olbers found Venus at its greatest brilliancy 19 to 23 times as bright as Aldebaran, but Plummer estimated it as nine times brighter than Sirius, which would make it 56 times brighter than Aldebaran. Mercury is perhaps about equal to Aldebaran when at its greatest brilliancy. I compared the planet and the star in June, 1874, in India, and found them about equal.

Assuming that when Venus is at her greatest brightness she is distant from the sun 66 millions of miles, and that in this position she subtends an angle of 40 seconds of arc, and taking the corresponding quantities for Mercury as 28 millions and 8½ seconds respectively, I find that Venus should appear about four times brighter than Mercury. Taking Venus as 20 times brighter than Aldebaran, we have the albedo of Venus equal to five times that of Mercury. Zollner found for Mercury an albedo of 0·13. My calculation would, therefore, make the albedo of Venus equal to 0·13×5 or 0·65. Zollner found 0·50. The data used in the above computation are too uncertain to yield an accurate result. For the planets outside the earth's orbit, let us take Mars as our standard. For this planet Zollner found an albedo of 0·2672, or about double the albedo of Mercury. For the minor planets we have hardly sufficient data to enable us to compute their albedos; these little planets being so small that the apparent diameters of their disks cannot be accurately measured.

Comparing Mars and Jupiter, we have the mean distances from the sun represented by the numbers 1·523 and 5·20. Their surfaces are therefore illuminated by sunlight in the inverse ratio of the squares of these numbers. That is, the solar illumination on Mars is to the solar illumination on Jupiter as the square of 5·20 to the square of 1·523, or as 27·04 to 2·32; and the apparent diameter of Mars at mean opposition may be taken at 18 seconds of arc, while that of Jupiter is 46 seconds. Hence the illuminated surface of Jupiter is $(\frac{46}{18})^2$, or 6·53 times that of Mars. The relative brightness of the two planets should therefore be $\frac{2704}{2 \cdot 32 \times 6 \cdot 53}$ or 1·78; that is, Mars should be 1·78 times brighter than Jupiter. Now Pickering found the stellar magnitude of Jupiter, when in opposition, to be 2·52, or about 2½ magnitudes brighter than the zero of the scale of magnitudes, and that of Mars 2·25. This makes Jupiter 1·2823 times brighter than Mars. But we have seen that Mars should be 1·78 times brighter than Jupiter. Hence Jupiter is 1·78×1·2823=2·2825 times brighter than it should be had it the same albedo as Mars. The albedo must therefore be 0·2672×2·2825=0·609. Zollner found an albedo of 0·72, but Bond computed that Jupiter emits more light than it receives from the sun (Chambers' "Descriptive Astronomy," 3d edition, p. 117). This would suggest that the planet shines with some inherent light of its own, a conclusion which has been also arrived at from other considerations.

In the case of Saturn the existence of the bright rings complicates the observations of the planet's brightness. Pickering's photometric measures make it about equal to a star of the first magnitude when in opposition and the rings invisible. Mars is therefore 3·25 magnitudes, or about 20 times brighter than Saturn. Now the relative distances of Mars and Saturn from the sun are represented by the numbers 1·523 and 9·539. The squares of these are 2·32 and 90·99, which implies that the intensity of the solar light on Mars is 39·2 times that on Saturn. Taking the

apparent diameter of Mars at 18 seconds and that of Saturn at 19 seconds, we have the apparent surface of Mars $(\frac{18}{19})^2$, or $\frac{324}{361}$ that of Saturn. Mars should therefore be $39{\cdot}2\times\frac{324}{361}$, or 35·17 times brighter than Saturn. But it is only 27 times brighter. Hence the albedo of Saturn must be greater than that of Mars in the ratio of 35·17 to 27, or the albedo of Saturn $=\frac{35{\cdot}17}{20}\times 0{\cdot}2672=$ (0·47). Zollner found 0·4981. I am inclined, however, to think, from my own observations, that Saturn, when in opposition and shorn of his rings, is slightly brighter than a star of the first magnitude. If this be so, the albedo would have a somewhat higher value than that just computed.

Coming now to the planet Uranus, we find the highest albedo of all the planets. Zollner found 0·64, or slightly greater than that of Jupiter, but I find a still higher value. The relative distances of Mars and Uranus from the sun are 1·523 and 19·183. The squares of these numbers are 2·32 and 367·99. Hence the intensity of the solar illumination on Mars is $\frac{367{\cdot}99}{2{\cdot}32}$, or 158·6 times that on Uranus. Taking the apparent diameter of Uranus at 4 seconds, and that of Mars at 18 seconds, as before, we have the area of the disk of Mars $(\frac{18}{4})^2$ or 20·25 times that of Uranus. Hence Mars should exceed Uranus in brightness $158{\cdot}6\times 20{\cdot}25$, or 3211·65 times, if both planets had the same albedo. Now Zollner found the stellar magnitude of Uranus to be 5·46; Pickering finds 5·56, and my own eye observations make it about 5·4. We may therefore safely assume its brightness at 5·5 magnitude. This gives a difference of 7·75 stellar magnitude between Mars and Uranus, and implies that Mars is 1259 times brighter than Uranus. But we have seen that Mars should be 3211·65 times brighter if the surfaces of the two planets had the same reflecting power; hence it follows that the albedo of Uranus must be $\frac{3211{\cdot}65}{1259}$, or 2·55 times greater than that of Mars. We have, therefore, the albedo of Uranus $=0{\cdot}2672\times 2{\cdot}55=0{\cdot}68$, or nearly equal to that of white paper, which is 0·70.

Let us now consider the planet Neptune, for which Zollner found an albedo of 0·46. The relative distances of Mars and Neptune are 1·523 and 30·054. This gives the solar illumination on Mars 389·32 times that on Neptune. Taking their apparent diameters at 18 seconds and 2·9 seconds respectively, we have the result that Mars should be 14,996·6 times brighter than Neptune. Now Pickering found the stellar magnitude of Neptune to be 7·96, which makes Mars 10·21 magnitudes, or 12,023 times brighter than Neptune. Hence we have the albedo of Neptune $=\frac{14996{\cdot}6}{12023}\times 0{\cdot}2672=$ 0·333, a result in striking contrast to the albedo found above for Uranus. I think there can be no doubt that Uranus has the highest albedo of all the planets of the solar system. Comparing it with Jupiter I find, by the same method of computation, that the albedo of Uranus = albedo of Jupiter × 1·213. Hence with Zollner's value of Jupiter's albedo 0·62, we have the albedo of Uranus 0·75, a very high value indeed, exceeding that of white paper, which is 0·70, and pointing strongly to the conclusion that Uranus is in a highly heated condition, a conclusion which seems to be partly supported by the evidence of the spectroscope.

To further test the high albedo of Uranus, let us compare the relative brightness of Uranus and Neptune. According to Prof. Pickering's photometric measures, Uranus is 5·56 magnitude and Neptune 7·96. Uranus is therefore 2·4 magnitudes or 9·12 times brighter than Neptune. The relative distances of the two planets from the sun being 19·183 and 30·054, we have the intensity of the solar light on Uranus 2·4545 times that on Neptune. But the areas of the disks are as 4^2 to $(2{\cdot}9)^2$, or as 16 to 8·41. Hence, the brightness of Uranus should be $\frac{16}{8{\cdot}41}\times 2{\cdot}4545$ or 4·67 times that of Neptune. Hence it follows that the albedo of Uranus must be $\frac{9{\cdot}12}{4{\cdot}67}$, or 1·9528 that of Neptune. Assuming Zollner's value of 0·46 for the albedo of Neptune, we have the albedo of Uranus $=0{\cdot}46\times 1{\cdot}9528=0{\cdot}898$ (!) Even with the low value of Neptune's albedo, which I have found, viz., 0·333, the albedo of Uranus would be $0{\cdot}333\times 1{\cdot}9528=0{\cdot}65$, a value which still makes its albedo the highest of all the planets.

It is difficult to say what the albedo of the earth itself may be. Possibly it does not differ much from that of the planet Mars. The moon's albedo is rather low, 0·1736, according to Zollner. It is, however, greater than that of Mercury, which seems to have the smallest reflecting power of all the planets.

With reference to the satellites, those of Mars are so small that we have no data for computing their albedos. Prof. Pickering's estimates of their diameter were made on the assumption that their albedos do not differ much from that of Mars itself.

Assuming a diameter of 3,400 miles for the third satellite of Jupiter, the largest and brightest of the system, and the mean diameter of Jupiter itself at 87,000 miles, we have the area of Jupiter's disk 655 times that of the satellite. If both have the same albedo, Jupiter should therefore be 655 times brighter than the satellite. Now Pickering finds the stellar magnitude of this satellite to be 5·24. This makes Jupiter 7·76 magnitudes or 1,271 times brighter than the satellite. Hence the albedo of Jupiter must be nearly twice that of the third satellite.

The diameter of Saturn's largest satellite, Titan, is somewhat doubtful, but assuming it at 3,000 miles, and its stellar magnitude to be 9·43 as measured by Pickering, the diameter of Saturn being 72,000 miles, I find the albedo of Saturn would be 2·2 times that of Titan. This would make the albedo of Titan about 0·21, but owing to the uncertainty which exists as to its diameter, this result must be considered very doubtful.

The satellites of Uranus and Neptune are so faint that no satisfactory results could be computed. For the satellite of Neptune, Pickering finds a stellar magnitude of 13·82, or 5·93 magnitudes fainter than its primary. If we take the diameter of Neptune at 36,000 miles, and assume that its albedo is twice that of its satellite, I find that the diameter of the satellite would be about 3,300 miles. Assuming the same albedo, the diameter would be about 2,340 miles.—*Knowledge.*

VELOCITY OF SOUND IN MEMBRANEOUS BODIES.

By F. MELDE.

THE author gives the following extract from a longer memoir which is shortly to appear.

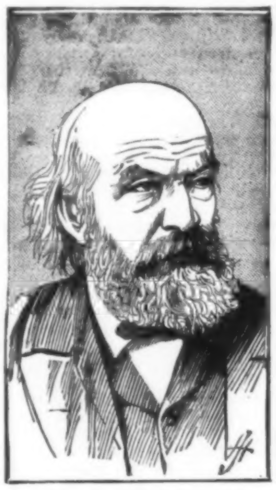
By membraneous bodies he understands such bodies as are capable of forming a membrane, which can be used for all purposes for which membranes can be applied. To these belong, for instance, the various kinds of paper, linen and cotton materials, caoutchouc, animal membranes, etc. The velocity of sound in such bodies differs greatly, but can be easily determined by fixing narrow strips at both ends, rubbing them in the middle, and determining the pitch of the fundamental note. If the number of vibrations is n, and the length of the strip L, then $L=\frac{\lambda}{2}$ and $2L=\lambda=$ the wave length of the note in question; so that the velocity is $v=n\lambda$. In this way the following numbers were obtained for the velocity of sound:

	Meters.
Paper soaked with wax	3,040
Stout red parchment paper	2,960
Yellow silk paper	2,046
Drawing paper	1,955
Smooth green paper	1,852
Yellow satin ribbon	1,950
Black paper	1,923
Red paper	1,852
Hemp string	1,720
Cotton string	1,280
Colored cross-ribbed silk ribbon	930
Black wax cloth	570

—*Beiblatter der Physik*, vol. xv., p. 756; *Phil. Mag.*

PROFESSOR JOHN C. ADAMS.

THE late Mr. John Couch Adams, Lowndean Professor of Astronomy at Cambridge, was born at Lidcot, near Launceston, in 1819. He evinced an aptitude for



PROFESSOR JOHN C. ADAMS

mathematics and astronomy at an early age. In 1843 he graduated as Senior Wrangler at Cambridge, was soon after elected to a Fellowship, and was appointed one of the mathematical tutors of St. John's College. Bending his mind at once to the consideration of a problem which was puzzling the astronomers at the time—the irregularities in the motion of Uranus—in two years he was able to arrive at its solution. The credit for the discovery is partially shared with Leverrier, the French astronomer. An Adams Prize for an essay on pure mathematics was established at Cambridge to commemorate the great discovery, and is awarded every two years.—*The Graphic.*

BENJAMIN THOMPSON, AFTERWARD COUNT RUMFORD.

THE founder of the Royal Institution, Count Rumford, had so remarkable and eventful a career that it will be of interest, says *Engineering*, to give some particulars of his life.

Benjamin Thompson, who afterward became Count Rumford, was the son of Captain Ebenezer Thompson, and was born about twelve miles from Charlestown, in Massachusetts, on March 26, 1753. He began his education at the village school, and afterward went to the grammar school at Medford, a few miles distant. At the age of thirteen he was apprenticed to a general dealer in the town of Salem, but was perpetually in trouble from his propensities to make things for himself instead of attending to his duties in the store, and at the age of sixteen he began to take interest in matters of science, and wrote to a friend on the subject of light, heat, and the wind. At the age of seventeen he was again apprenticed in a dry goods store in Boston, and in the summer of the following year we find him studying in the University of Cambridge (Mass.), and attending Winthrop's lectures on "Experimental Philosophy." After that he became a schoolmaster, and taught in schools at Wilmington, at Bradford, and at Concord, the name of which town had not long before been changed from Rumford. Before he was twenty he married the rich widow of Colonel Rolfe, and through this marriage he became one of the most influential men in Concord.

Some time after his marriage he was introduced by his wife to Governor Wentworth, who gave him a commission as major in the second provincial regiment of New Hampshire. This was about the time that the discontent against British rule was rapidly ripening into civil war, and he became so unpopular in Concord on account of his being in favor with the governor and the British officers that he had to escape from the town and accept the shelter offered him by a friend in Charlestown. When Boston fell in 1776, Benjamin Thompson was sent to England with the news, and was appointed secretary of the province of Georgia, and in the following year he made the acquaintance of Sir Joseph Banks, with whom he was afterward so intimately connected in the early days of the Royal Institution, and about this time he conducted a series of experiments on gunpowder and on a method of measuring the velocity of projectiles. The results of these experiments he sent to the Royal Society, and this communication was the first of his researches that was published in the Philosophical Transactions.* This was a most important, and is one of the first attempts to treat the force of projectiles and the force of explosives from a mathematical point of view. In the same year, 1778, Thompson was elected a fellow of the Royal Society. In 1780 he was made Under Secretary of State for the Northern Department of America by Lord St. Germain. He was at the same time Secretary for the State of Georgia, inspector of all the army clothing sent to America, and Lieutenant Colonel Commandant of Horse Dragoons at New York, and possessing a very large income. During the war which followed, Colonel Thompson's name was repeatedly mentioned in dispatches for his power of organization, and for his conduct in the field.

In the year 1783, when he was thirty years of age, he went over to the Continent with the object of taking part in a war which was then expected between Austria and Turkey, but by a purely accidental circumstance he met at Strasburg the Prince Maximilian des Deux Ponts, afterward Elector of Bavaria, who was at that time an officer in the French service; they became great friends, and on his leaving, the prince gave him a letter of introduction to his uncle the Elector of Bavaria, begging him to take Munich on his way. At Munich he was received with princely hospitality, and the result of that visit was that he became aide-de-camp to the Elector of Bavaria.

In February of the same year, 1784, Thompson was knighted by George the Third, and received permission to enter the service of the Elector of Bavaria. His first work under his new master was to reorganize and rearrange the military service, introducing a new system of order, discipline, and economy among the troops, uniting the interest of the soldier with that of civil society by making the military force subservient to the public good even in times of peace, while he acted on the principle that "to make soldiers citizens, and citizens soldiers, the soldier must be better paid, better clothed, better housed, better taught, better occupied, better amused, and above all allowed to earn money and to spend it as he pleased."

He established fixed garrisons and employed the military on useful public works, military gardens were laid out to introduce the culture of the potato, and workhouses were established at Mannheim for the manfacture of army clothing, and afterward at Munich, and it was the magnificent commercial success of the Munich establishment that, as we have seen at the beginning of this history, indirectly became the origin and antetype of the Royal Institution. By his military workhouses and his house of industry for the poor he completely cleared the city of Munich from beggars, and relief was given to those who never were beggars, but who were unable to provide for the necessities of life.

He founded a military academy for bringing forward boys showing remarkable talent, and making them fit for the civil or military public service, and he instituted public measures for improving the breed of cattle and horses in Bavaria, and the English garden, which is so great an ornament to the city of Munich, was established and laid out by Sir Benjamin Thompson, and in its midst he placed a café for refreshment and public resort, which excellent institution has been copied in all the public gardens on the Continent.

It was while in the service of the Elector of Bavaria that Sir Benjamin Thompson made the most important of his researches on heat, or the relative warmths of various methods for clothing, on the velocities of projectiles, and the force of recoil of guns, and it was with the object of determining the best form of illuminant for lighting the great workhouse at Munich that he devised the well known Rumford photometer, by which the relative intensities of two lights may be determined by their shadows. In 1794 he communicated to the Royal Society a most interesting paper upon some experiments with colored shadows; this was read on February 6, and was printed in the "Philosophical Transactions."†

He after this period received many new honors and distinctions for his further and scientific labors. He was made, in the year 1785, chamberlain to the Elector of Bavaria, and was also elected a member of the Bavarian Academy of Sciences. In 1786 the King of Poland, at the request of the Elector, conferred on him the Order of St. Stanislaus, and in 1787 he was elected a member of the Academy of Science in Berlin. In 1788 he became major-general of cavalry and privy councilor of state to the Elector of Bavaria, and became minister of state for the War Department, and in 1789 he was elected a foreign honorary member of the American Academy of Arts and Sciences, and became lieutenant-general of the Bavarian armies, while in 1791 he was made a count of the Holy Roman Empire by the Elector of Bavaria, who was for a short time one of the imperial vicars, and who at the same time conferred on him the Order of the White Eagle.

A few months after he became a count, he lost his wife, whom he had left since his first visit to Europe, she having been living in America with her son by her first husband, and her daughter, who was Count Rumford's only child.

In 1795 he returned to London, and then it was that he wrote the essays which are ever associated with his name, and which were published in 1796.‡

* Philosophical Transactions of the Royal Society, No. xv., page 229, London, 1778.

† "Philosophical Transactions," 1794, No. x., p. 107, "An Account of some Experiments on Colored Shades," by Lieutenant-General Sir Benjamin Thompson, Count of Rumford, F.R.S.

‡ "Essays, Political, Economical, and Philosophical," by Benjamin, Count of Rumford. London, 1796.

It was in this year that he founded the Rumford Medal of the Royal Society, which is given every second year to the author of the most important discovery or useful improvement relating to heat or light.

The connection between the House of Industry for the poor at Munich, which formed the subject of his first essay, and the inception and development of the Royal Institution has already been referred to in this history, and from the year 1799 until his death, the life of Count Rumford became part of the history of the Royal Institution and for a few years after he lived partly in London, partly in Munich, and partly in Paris, where he met Madame Lavoisier, the wealthy widow of the celebrated chemist, whom he married on October 24, 1805. A more miserable alliance from the first than this marriage could hardly be imagined, and after three years and a half of increasing discomfort and unhappiness they separated on June 30, 1809, to the inexpressible relief of both parties.

After this we find him again in Munich, the guest of the King of Bavaria, but he returned to Paris, and in 1811 his daughter, whom he had left in America thirty-six years before, joined him at Auteuil, and was visited by her father's separated wife, of whom she wrote in the most enthusiastic terms of admiration. "The lady," she says, "was gracious to me, and I was charmed with her, nor did I ever after find reason to be otherwise, for she was truly an admirable character." After this time Rumford communicated several papers both to the Royal Society and to the Academie des Sciences, but his health gradually failed, and he died at Auteuil, on August 21, 1814, in the sixty-second year of his age.

MR. SPURGEON.

MR. CHARLES HADDON SPURGEON, Pastor of the Metropolitan Tabernacle, London, died at the Hotel Beaurivage, Mentone, soon after 11 on Sunday night, January 31, 1892. The final illness was a return of the former trouble—namely, congestion of the kidneys, complicated by gout.

By the death of Mr. Spurgeon, English Nonconformity has been deprived of a remarkable man, a man of striking power and strong personality, a man who has left upon the religious life of his generation a mark deeper, if less wide, than that which will be left by his contemporary of the Salvation Army. The British Islands have not failed to produce leaders of religious thought as generation followed upon generation from the days when Tactius spoke of *inaccessa Romanis loca Christo tamen subdita* even until now. In the religious leader who has gone to his rest the English-speaking world has lost a man of great power, of shrewd common sense, of remarkable influence; a man who could answer far better than the majority of men that searching question of Carlyle's, "Man, what is thy work?"

If there be such a thing as heredity in religion, then Charles Haddon Spurgeon was a hereditary Puritan. Mr. Spurgeon took just pride in his religious proclivities, which he inherited from his ancestors; and in a sermon preached not many years ago he adverted to the subject. "When I spoke the other day, with a Christian brother, he seemed right happy to tell me that he sprang of a family which came from Holland during the persecution of the Duke of Alva, and I felt a brotherhood with him in claiming a like descent. I dare say our fathers were poor weavers, but I had far rather be descended from one who suffered for the faith than bear the blood of all the emperors within my veins." As a matter of fact, the immediate ancestors of the late Mr. Spurgeon were Nonconformist ministers. His father, John Spurgeon, preached to an Independent congregation on Sundays for 16 years in Essex and then became a regular pastor, first at Cranbrook, then in Fetter lane, and last at Upper street, Islington. His grandfather, James Spurgeon, was for more than half a century pastor of the Independent church at Stambourne, in Essex. Mr. Spurgeon's ancestors were, in fact, among those Protestants from the Netherlands who settled on the East Coast to avoid religious persecution in their own country; and it is recorded that they were not entirely free from persecution in their adopted country, since one of them, at least, "suffered imprisonment for conscience' sake" in the time of Charles II. Charles Haddon Spurgeon himself was born on the 19th of June, 1834, at Kelvedon, in Essex. Much of the embryo pastor's early life appears to have been spent under the care of his grandfather at Stambourne, and that early life appears, according to all the numerous accounts which have been written, to have been of a highly characteristic nature. An admiring biographer wrote in 1887, "The pious precocity of the child soon attracted the attention of all around him. He astonished the grave deacons and matrons who called on his grandfather on Sabbath evenings by the serious, intelligent questions he asked, and by the pertinent remarks he made." "It is said on good authority," continues the biographer, "that before he was six years old he publicly reproved sinners in the street." *Se non è vero è ben' trovato*, and the same observation applies to the story concerning a certain backsliding member of the Independent community at Stambourne who appears to have been addicted, albeit not beyond the bounds of moderation, to the use of beer and tobacco. The backslider's account appears to have been to the effect that the child confronted him in the village ale house with upraised finger and the words, "What doest thou here, Elijah?" These accounts may, of course, be apocryphal; they may be the mere legends, illustrative of man's capacity for hero worship and saint making, which have grown round the history of the childhood of Charles Spurgeon, but the probability is they have, at least, a substratum of truth in them, and it may well be imagined that the child who was to become one of the most determined and one of the most confident of preachers started in life with considerable capacity for believing in the correctness of his own views.

Charles Spurgeon's education was not of the best. He appears to have gone to a school at Colchester, at seven years old, and to have stayed there for four years. For three years more we may presume that he was kept to lessons of some kind, and in 1848 he appears to have spent some time at an agricultural college at Maidstone. In 1849, when he served for a short time as an usher in a school at Newmarket, and in the following year, when he was beset by skeptical doubts, he underwent that mental, moral, and spiritual process of conversion (at a Primitive Methodist chapel) which was placed in evidence by his public baptism at Isleham, Cambridgeshire, in 1850.

Very soon after his conversion he became a member of a lay preachers' association at Cambridge, and preached in the neighboring villages, earning his living as an usher in a school at Cambridge during the week.

In 1852, Mr. Spurgeon, being 18 years of age, became pastor of the Baptist church at Waterbeach, and, not long after this, he escaped that more complete education which his parents desired to give him by a ludicrous accident. Dr. Angus, the tutor of Stepney (now Regent's Park) College, visited Cambridge, and young Spurgeon went to meet him at the house of Mr. Macmillan, the publisher. After waiting in a room by himself for two hours he found that the Doctor had also been waiting in another apartment, not having heard of his arrival, and had gone off by train to town.

Mr. Spurgeon was too valuable a preacher to be left long in the retirement of Waterbeach. While there he distinguished himself in characteristic fashion. Being asked to preach the anniversary sermon at a neighboring village, he presented himself to the pastor, who, astonished at his youth, spoke of "boys going up and down to country preaching before their mothers' milk was well out of their mouths;" but the young preacher promptly preached a sermon upon the text, "The hoary head is a crown of glory" (Prov. xvi.), the character of which may be guessed from the fact that his aged colleague accosted him as "the sauciest dog that ever barked in a pulpit." This little village, hovever, was not the only place in which Spurgeon's voice was heard, and an address delivered by him at Cambridge, in 1852 or 1853, brought him rapid preferment. One Mr. Gould, of Laughton, heard the young preacher; he carried the news of his power to Mr. Olney, a deacon of the New Park street chapel. Now the New Park street chapel was one of the most ancient Baptist institutions in London. It had been established two centuries before by Puritan Baptists; its pastorate had been held by William Rider; by Benjamin Keach, of "metaphors" renown; by Benjamin Stinton; by John Gill, a noted commentator; by John Rippon, the editor of the Baptist hymn book; by Joseph Angus, and James Smith. But New Park street was in low water and the deacons were on the look-out for a man capable of multiplying a congregation of 100 by 12 and so filling 1,100 empty seats. Mr. Olney wrote to Mr. Spurgeon. The young preacher thought the invitation was wrongly addressed and so answered. It was no mistake, but the beginning of Mr. Spurgeon's remarkable metropolitan career. Very soon the young preacher was appointed permanent pastor, very soon the 1,200 seats had to be increased to 1,800. Invitations to preach in various parts of the country came rapidly, and he did preach to overflowing congregations, under roofs, and in the open air, with conspicuous success. While the New Park street chapel was being enlarged, Exeter Hall and the Surrey Music Hall, at which Lord Campbell is said to have attended, were pressed into service. The large congregations which were attracted by Mr. Spurgeon's discourses were noticed in *The Times* of those days. In 1857 he preached to an assemblage of 24,000 people at the Crystal Palace in connection with the Indian Mutiny. In 1859 the foundation stone of the Metropolitan Tabernacle was laid, a Bible, the Baptist Confession of Faith, the declaration of the deacons, and Dr. Rippon's hymn book being placed underneath it. In 1861 the Metropolitan Tabernacle, capable of accommodating between five and six thousand persons, was opened free from debt. Since then various great institutions have grown up in connection with the Tabernacle, the principal being the Pastors' College, the Colportage Association, the Almshouses, the two Orphanages at Stockwell, and the Mission Hall at Bermondsey—all brought into being and maintained by the energy of one man. In 1862 came a memorable controversy concerning baptismal regeneration. Three hundred thousand copies of Mr. Spurgeon's sermons on the subject were circulated, and the controversy roused by them was so fierce that he dropped the prefix of Reverend, and became, if possible, more of a free lance preacher than before.

In politics Mr. Spurgeon exercised an active influence. A man of his oratorical strength, who was in the habit of addressing huge congregations, who did not shrink from alluding to the events of the day, could hardly fail to be a power, and the trenchant attack which he made upon Mr. Gladstone's Irish policy of 1886 was a serious blow to the influence of that sometime leader of the Liberal party. Of Spurgeon literature there is almost a library. "The Saint and his Saviour" came out in 1867; in 1868 "John Ploughman's Talk" was published and obtained, before 1887, a circulation of 350,000; 1872 brought to light "The Treasury of David" in seven volumes, and numerous religious works bear his name. A strong tribute is due also to the energy shown by Mr. Spurgeon in the education of young ministers, of which the Pastors' College is the visible sign.

It was as a writer and a preacher of sermons that Mr. Spurgeon exercised most powerful influence. An American author wrote of him that the chief sources of his power lay "in his wonderfully original, natural, and impressive delivery, his marvelous command of simple, precise, idiomatic Saxon language, and his red hot earnestness and singleness of purpose." There was justice in this rather superlative criticism, but for all that it did not describe Mr. Spurgeon's method adequately. Readers of his multitudinous sermons, which have been published regularly for nearly forty years, can hardly fail to be struck with them in many ways. They will notice in them a strong egotistical and anecdotal tendency, an outspoken defiance and confidence of tone, a fierce hatred of "the *Cloaca Maxima* of Rome," a detestation of anything and everything that is sham or artificial, a determination to be lively, an aptitude in the use of strong and familiar phrases. "There is raw material in a publican which you seldom find in a Pharisee. A Pharisee may polish up into an ordinary Christian; but somehow there is a charming touch about the pardoned sinner which is lacking in the other"—such is an example of his aptitude in familiar phrase taken from a "manifesto" of faith embodied in a sermon of April 25, 1890. The liveliness of the discourses is systematical and deliberate; witness the preface to the first volume of sermons published in 1856, in which the preacher says that "he is not quite sure about a smile being a sin, and, at any rate, he thinks it less crime to cause momentary laughter than a half hour's slumber." On this principle he preached throughout a tolerably long life, with the result that he obtained hearers in thousands when scholarly men could not obtain them by hundreds or even by scores; and had an almost unbounded influence over large bodies of men and women, chiefly in the lower middle classes. This eloquent and energetic preacher, who was almost worshiped by his immediate followers, whose views of things in daily life were abnormally shrewd, who was the personal friend of President Garfield and of Lord Shaftesbury, whose words were widely read, not only in Great Britain, but all the world over, who entertained by the flashes of his shrewd wit even those who were not attracted to his principles, will leave a great and visible gap in English life.—*London Times.*

DIET AND EXERCISE IN THE TREATMENT OF SIMPLE CHRONIC INFLAMMATION.*

By J. C. MULHALL, M.D.,† St. Louis Mo.

THE subject of my remarks is apparently commonplace, yet many experiences with patients forces me to conclude that the dietetic and general hygienic management of individuals with chronic inflammatory disorders is either totally neglected, parenthetically mentioned, insufficiently explained, or made of secondary importance to treatment by drugs by a large number of physicians.

Yet I venture to lay before you the proposition that for the cure—real, not transitory—of a chronic inflammation, surgical treatment excluded, nine-tenths of the success will be due to skillful dietetic and hygienic management, and one-tenth to drugs, locally or systemically applied.

To select a common example, chronic nasal catarrh. I beg to declare that, atrophy, deformity, or permanent obstruction being absent, the above proposition is strictly correct; that the correct management of clothing, food, exercise, atmosphere, skillfully applied according to individual cases, will do nine-tenths, and medication, local and systemic, one-tenth, of whatever good may be accomplished.

The testimony of many patients, that the selection and preparation of their food, the manner and amount of physical exercise, had not been insisted on by former medical advisers, forms the ground for my assertion.

If, then, my proposition and assertion be true, no further apology is necessary for the triteness of my subject.

It may be stated, broadly, that the vast majority of simple, non-specific chronic inflammations in the human body are caused by the faulty habits of the individual. There are exceptions. For example: where the intensity of an acute process has produced such anatomical death that regeneration of tissue is impossible; to illustrate my meaning, that incurable disease, atrophic rhinitis, rapidly following diphtheritic or scarlatinal rhinitis. Trace the life of an individual, from a hygienic standpoint, with constipation, hemorrhoids, leucorrhœa, endometritis, intestinal or stomachic indigestion, hepatitis, myocarditis, bronchitis, laryngitis, pharyngitis, rhinitis, eczema, neurasthenia, and a host of other disorders, and you will find in one or many ways that the laws of health have been long and grievously transgressed. The one has been overfed, underfed or badly fed, the other has neglected physical exercise. All other causes combined, including alcoholic excesses, are as nothing when compared with errors in diet and exercise in producing simple chronic inflammation.

It is to these two causes, dyspepsia and perverted nutrition, physical inactivity, and toneless muscles, nerves, and glands, that I attribute the extraordinary prevalence of chronic nasal catarrh in the United States. Our climate, our macadam streets, our furnace-heated houses, are but subsidiary to these two great primal causes. I have lived in many countries, and nowhere are candy, pastry, ice water, and hot bread consumed as by my countrymen, the Americans. In no country is food bolted so hastily; and, to heap error on error, nowhere is less attention given to physical exercise. Let me give an illustration that may also serve to dissipate reproach to our St. Louis climate. Eighteen months ago, a young gentleman of this city, Mr. Clark T——, came to me with the following history: From the age of twelve to twenty he had been a sufferer from more or less distressing chronic nasal catarrh. He had been subjected to much local treatment with but temporary relief. At the age of twenty he accepted a position in a small town in the State of Kansas. In the course of a year, without treatment, his nasal symptoms disappeared, and he remained well until, at the age of twenty-four, he returned to St. Louis. In the course of six months his old symptoms reappeared. He consulted the same specialist, but without relief. He naturally concluded that the St. Louis climate did not agree with him and had concluded to return to Kansas. I found him a plethoric, robust man, suffering the usual train of symptoms of chronic hypertrophic nasal catarrh, including violent and frequent headache. Direct questioning elicited the following: In Kansas he earned fifty dollars per month, out of which he clothed and boarded himself, was occupied in a bank from nine until three, and spent a part of nearly every day fishing or shooting.

In St. Louis he earned double the salary, out of which he did not pay for board and lodging, since he lived at his father's house, a wealthy man, fond of supplying his table with every luxury. The son was occupied from eight till six, and he never walked to or from business; in fact, took no physical exercise.

There was, therefore, on the one hand, in Kansas frugal diet, short business hours, much exhilarating exercise in the open air, and no temptation to dissipate; and on the other, a rich and generous diet, no physical exercise, and more money to gratify the

* Read before the St. Louis Medico-Chirurgical Society, St. Louis Medical Society, and Missouri State Medical Association.

† Professor of diseases of chest and throat, Beaumont Hospital Medical College; consultant in chest and throat diseases to Alexian Brothers' Hospital, St. Mary's Infirmary, South Side Dispensary; member of the Laryngological and Climatological Associations.

desires which the late hours of a large city spread before one. When I presented the two pictures to him he agreed that there might be other factors besides the relative atmosphere of the small Kansas town and St. Louis.

His face suffused easily on exertion, his bowels were inactive, his urine turbid—in a word, here was an individual in a high state of hypernutrition with defective elimination. Tonsils, pharynx, and nasal erectile tissue were in a state of vascular engorgement. How absurd to think of curing such an individual with local treatment! I was reminded of the advice of the great Abernethy to the rich and corpulent dyspeptic, "Earn a shilling a day and live off it."

He was ordered to live as he did in Kansas; all the luxuries of the table were denied him. He was ordered to walk rapidly two miles in the morning, and the like distance in the evening. From twelve to one, his lunch hour, he joined in the calisthenic exercises pursued at the Missouri Gymnasium, and partook of a very light lunch.

The hypertrophied areas in nose and throat were destroyed with the galvano-caustic, beyond which no local treatment was adopted. His diet and exercise were carefully regulated from time to time as I judged best.

This training process lasted six months, and ended in complete recovery. For the past year his weight and height correspond, he is stronger, though he weighs twenty pounds less, his bowels are regular, the urine clear, his nostrils unobstructed, he has not had a single headache, and in his case the question so often asked, "Is catarrh curable?" has been answered.

Here I may mention another case of nasal trouble, where the blunder of pursuing local treatment, to the exclusion of hygienic measures, merely increased the distress of the sufferer. Two years ago, a policeman, aged fifty, consulted me, complaining that for several months he had suffered from "catarrh," as so called by two rhinologists who had assiduously sprayed his nose, to his increasing discomfort. The nasal discharge was profuse, like distilled water, occasionally mucoid in character, saturating from three to ten handkerchiefs daily. The nasal mucous membrane was found to be pallid and very irritable, the picture, not of an inflammatory trouble, but of a vaso-motor paresis; other symptoms pointed to the disorder as a neurosis. His head and neck sweated easily, his face paled and flushed without apparent cause, the pupils were sluggish, he was nervous, he did not sleep well, and had grown quite irritable. In my endeavor to discover why a man who all his life had enjoyed good health had for several months past presented this array of symptoms, I found that for fifteen years he had been a mounted policeman, but that for the past eight months he had been relegated to a stuffy little office to do clerical labor. What a tremendous change in the life of an individual! His nose was not touched, no drug was administered. An explanation to the proper authorities secured for him a return to his horseback life, and within a month every morbid symptom had disappeared. I have seen him within a month, and the cure remains perfect.

The good influence of diet and exercise has been remarkably exemplified to me in the persons of two prize fighters, who applied to me for the treatment of chronic nasal inflammation. Nearly all of these men in the intervals between their prize ring encounters are in a state of atonic hypernutrition from excessive eating and spirit drinking, combined with physical inactivity; their bodies are filled with effete material. These men had tried many kinds of local medications, regular and irregular, with little or no relief, but both admitted, on direct questioning, that they had experienced absolute relief after they had undergone a system of training preparatory to entering the prize ring for an encounter. Both again admitted that, after several weeks' return to their former bar room lives, all their nasal symptoms reappeared.

Mr. B——, aged thirty-six, senior member of a well-known firm of wire rope makers in this city, will tell any one who asks him the following: He had for several years suffered from obstructive nasal catarrh, with viscid mucus and aching brows. He received local treatment at the hands of two specialists without relief. He began playing handball three times weekly, finishing after each occasion with a shower bath and vigorous rubbing. I shall not delay to explain why handball is one of the finest of physical exercises. It completely cured him in three months of his nasal trobbles.

Lest some critic, idiotically carping, should suggest that all cannot become prize fighters or handball players, I here say that I adduce these as illustrations of the soundness of my argument, as to the value of exercise in the cure of chronic inflammation. Let any of my hearers who, while he has not an acute coryza, has a feeling of dryness and stuffiness in the nostrils, take a rapid walk of two miles, and he will find that his nostrils have become freer, their mucous membrane moist, and there will be impressed on him the idea that chronic exercise may cure chronically stuffed noses.

I incidentally mentioned simple chronic endometritis. A lady friend and patient lately informed me that one of our best known gynecologists had packed the vagina with variously medicated cotton tampons and painted the wound weekly for fifteen months, with absolutely no success. What a loss of time and money and respect for the medical profession! She placed herself in the hands of two women doctors, who, practicing hygiene of the body alone, without touching womb or vagina, cured her. What a comment on the absurdity of drugs as compared with an enforcement of those laws of nature which control elimination and assimilation, and equalize vascularity in the organs! The American woman with her crooked womb cannot exercise, because it produces dragging pains in her back, and there is nothing left for her but a pessary and a drug.

The most magnificent tonic for the sluggish pelvic organs is the Swedish movement cure, a series of movements designed for the cure of chronic constipation, a condition very common in our American women, and one which all the drugs on earth will not cure. When, incidental to chronic affections of heart, lungs, or throat, I have encountered chronic constipation, I have made it a rule to first cure, if possible, this latter condition, and I cannot praise too highly the Swedish movement cure. After two or three weeks, a daily evacuation is secured, when two or three of the movements, with dieting, will secure daily evacuation. I do not mean to imply that the science of gynecology can be reduced to a hop, skip, and a jump; I but wish to say that in simple chronic womb inflammations, as elsewhere in the body, diet and exercise are by all odds the most important of curative measures. The Swedish cure is a proof that there is a scientific method of prescribing exercise.

Disorders of digestion frequently exhibit pathological reflexes on the respiratory track. The dyspeptic throat is fairly well known, but I have yet to read of the dyspeptic nose. If disorders in diet and exercise will produce piles in some individuals, why will not like errors, in other individuals, produce vascular changes in the nasal erectile tissue, where the cavernous sinuses have even less support than in the rectum? Over and over again have patients with nasal catarrh admitted to me that faulty digestion aggravated the nasal symptoms. Several have given me the curious information that the nasal discharge, always odorless, became fetid when suffering from bilious attacks.

All the great operatic singers are aware of two facts: one, that they cannot sing with precision after a full meal, the other that a bilious attack may entirely deprive them of the power of singing their scores. The soft parts in the larynx seem puffy, the cords are congested, the laryngeal movements lack snap and vigor. Local treatment merely aggravates such a condition.

Starvation diet, vigorous exercise, a blue pill followed by a saline, and the vocal disabilities disappear. How easy to understand that the cure of chronic stomach or intestinal catarrh may be of every importance in the treatment of chronic laryngitis or pharyngitis! The latter is very seldom a primary disorder; a mucous membrane so constructed as to admit of the tri-daily friction of food does not readily yield its health. Chronic pharyngitis is often but the expression of a disordered alimentary canal. I have known it to disappear after the cure of chronic constipation. Local treatment usually aggravates, never cures, the dyspeptic throat. Let me here cite an instructive case, as it not only exhibits the cure of such a throat, but the cure of several coincident ailments.

Mr. P——, of Hannibal, Mo., consulted me last year concerning his throat, about which he had become disheartened, since he had submitted to tri-weekly local applications, extending over a period of three months, without relief. He also had insomnia, less of memory, piles, constipation, flatulence, with occasional wandering pains. He was six feet high and weighed two hundred and fifty pounds. These symptoms and increase of weight were coincident, and had accumulated within five years. Previous to this he had been a carpenter, undergoing physical labor every day, and subsisting his family by the sweat of his brow. At that time he had suddenly grown comparatively wealthy, abandoned all physical labor, and had since lived on the fat of the land. With his wealth and luxurious habits began his ill health. He was placed on a frugal diet, given daily severe exercise, lost forty pounds in three months, when every morbid symptom disappeared. No kind of medicinal treatment was pursued.

When such reflex hyperæmias have existed sufficiently long, solid hyperplasias often result, and these can be seldom removed by any system of hygiene, and must be attacked surgically. In nose, pharynx and larynx such thickenings can easily be removed, but the bronchial tubes are inaccessible, and the hypertrophied mucous membrane often remains in spite of the utmost precision in the hygienic life of the individual, including appropriate climatic aid. Drainage is not here so perfect as in the upper air passages, and again, chronic bronchial catarrh is very frequently the sequel of an acute attack in childhood which has produced irrecoverable anatomical change; still, the results obtained by perfect hygiene are far more brilliant than those resulting from medication. As an example of dyspeptic bronchial tube, I have often seen the following clinical picture: A patient complains of having "caught cold" in his chest. He has had a subacute bronchial catarrh. It has persisted several weeks and its obstinacy alarms him, the more so that other such attacks have persisted but a week or two. He has taken the usual expectorants, used counter-irritation, but the cough persists; he finds his tongue flabby and coated, food is repugnant to him, his bowels are sluggish, his digestion is bad—in a word, he is "bilious." The correction of this evil is at once followed by a disappearance of the cough. Expectorants can but aggravate the digestive disorder, unless they perchance produce vomiting and complete loss of appetite.

I have in my own person a mild type of chronic bronchial catarrh, caused I think by the inhalation of tobacco smoke, pursued now for twenty years. My expectoration is mucoid, and so easily expelled that I am hardly conscious that I cough. I have had occasional bilious attacks, and invariably on these occasions my cough tightens, the mucus becomes viscid, acquires a musty taste, and is difficult of expulsion. I have, by patient inquiry, elicited the same facts from a large number of sufferers with chronic bronchitis. Such clinical facts clearly indicate the influence of digestive disorders upon those within the chest, and should make us pause before rushing to the prescription blank. When all the excretory functions of the bronchitic are physiologically active, when his constipation has been cured, when his skin is made insensitive to temperature changes, when his food and exercise have been regulated to a nicety, these are the true expectorants and tonics.

If we consider the functional and organic diseases of the heart, my experience is that it is very seldom that a former medical adviser has not been careful to inquire into the condition of stomach and bowel in the functional cases, but that very frequently in the organic cases the health of the alimentary canal has not been supervised, nor has exercise been scientifically dictated.

The long, sighing inspiration, the flatulent sigh, the sense of oppression in chest or throat, the dyspnœa caused by the stomach distended with gas, is explained, I think, as follows: The inflation of the stomach with gas causes it to press against the bases of the lungs, thus mechanically interfering with the oxygenation of the basal air vesicles during quick respiration. The patient then feels a sense of air hunger, and a long forcible inspiration follows, which for a time sufficiently aerates the oxygen-hungry vesicles at the pulmonic bases. This balloon stomach also mechanically interferes with the movements of the heart, and its irregular action often ensues. The fluttering heart, the chest oppression thus produced, cause the patient to suspect heart disease. I have twice been called to see rheumatic subjects, in consultation, where such a condition had suggested beginning cardiac rheumatism. In one the tympanitic note was elicited even in the left axilla, and at mid-sternum. A stomach tube quickly restored peace. I have known this balloon stomach to produce convulsions and unconsciousness. I can only explain the fact that the gas does not escape by assuming that the distention must produce at the pyloric or cardiac orifice, as frequently at the entrance to the œsophagus, spasmodic stricture.

Oertel was the first, I believe, to dispel the old illusion that patients with certain organic affections of the heart should beware of active physical exercise, and his hill climbing and dietetic treatment in such cases has obtained world-wide recognition and indorsement. Many such patients are condemned to a life of physical inaction by their physicians. The consequence often is that they increase in weight, their muscles become flabby, their systems full of effete material, their capillaries become turgid, their ventricles more and more engorged during diastole, necessitating increased activity during systole, with final lack of compensation. Such a condition often explains why one patient with a certain valvular lesion soon becomes dropsical, while another with the same lesion, but whose diet and physical exercise have been nicely adjusted, goes on for years and years attending to the ordinary duties of life, experiencing little or no evil results from his leaking heart. In no other class of patients is it more important that the weight of the individual should conform to his stature. Every pound of physiological over-weight imposes just so much more labor on the heart. Such an organ, that must supply thirty pounds of useless over-weight, has imposed on it night and day a useless, wearisome labor that finally tells on its muscular fiber.

It is the physical training of the pugilist which enables his heart to withstand the mighty strain that a prolonged encounter puts upon it, and many a fight has been lost by a pugilist for lack of skill in his trainer in preparing his pupil's heart. Once more let me add that I am not indorsing a system of physical training such as pugilists, oarsmen, and athletes generally undergo in preparing for their events. On the contrary, I am quite sure of the evil effects of such a course. The youth who adds three inches to his biceps with six months of exercise has a badly developed biceps. The flat chested individual who, as a prophylactic measure to phthsis, develops the girth of his chest three inches within six months, will have an improperly developed chest. Nature resents such sudden attempts at development. While enthusiastic in the knowledge of what physical exercise may do for health, no one is more cautious than I in the way in which it should be done, in each individual; for no laws that govern all cases can be given.

Why are so many physicians neglectful in the matter of prescribing physical exercise? One reason is, I think, in their manner of recommending it. The usual advice is, "You must take more exercise." This usually enters one ear, makes a faint impression on the cerebrum, and departs from the other. Exercise should be prescribed accurately, just as accurately as a drug. If the patient be told that he must walk forty blocks per day, at a certain rate of speed, this is definite advice; and so with whatever exercise is enjoined, its art, manner, duration, degree, and persistence must be explained and insisted on. I tell my patients that unless they do exactly as I dictate, they must in no sense hold me responsible for failure to cure. It is not the fault of our science if the business man or housewife declares he or she has no time to exercise. It is much easier to take pills, but they will not cure simple chronic inflammation. A dozen houses in our country find it profitable to manufacture pepsin, a drug that merely plays with the physiology of the stomach, a drug that nearly always is prescribed in the imbecile effort to replace diet and exercise. Three quack medicines flourish in the United States where one does in any other civilized country; ours is the country of dyspepsia and catarrh. The American believes in drugs, and that charlatans discover combinations which the scientific physician cannot. He believes that for every physical evil there exists an antagonizing pill.

Another reason why medical men are careless in advising physical exercise is that many of them have never experienced in their own persons any kind of physical training. I do not wish to say that a doctor must be a gymnast in order to understand the wonders of physical exercise, but I will be understood when I say that what one has experienced in his own person is so impressed on him that he in turn is far more apt to impress the like on his patients. Moreover, a personal experience in all methods of physical training naturally gives one a better knowledge as to the method and amount of exercise which should be prescribed to meet a given indication.

To intelligently prescribe exercise presupposes on the part of the physician an excellent knowledge of physical diagnosis. He will commit many a mistake who is not expert in determining the condition of heart and lung. Oertel has reported some brilliant successes in his hill-climbing and dietetic treatment of certain organic heart diseases. How could he select fit cases and determine their progress were he not a master of physical diagnoses? As I have before said, physical exercise is potent for evil as well as good, and no one but a physician, in all that this word means, is the ideal trainer of the bodies of men. I do not pretend in this paper to go into the details of prescribing exercise, but I cannot refrain from mentioning two points. One is that the exercise should not be selected which is sure to be abandoned after a while, and the other that the exercise should if possible divert the patient's mind from the fact that it is exercise. The game of handball is one of skill and pleasure, and hence is robbed of the incubus which men often feel when they are conscious at the time that they are exercising for the sake of health.

Just as with exercise, so with diet. Many physicians are not painstaking and exact in their advice. A case will illustrate. I lately congratulated a lady friend, who had always been a sufferer from some ail

ment, on her appearance of health. She assured me of her perfect health, and declared her gratitude to Dr. Hardaway, whom she had consulted for some disease of the skin, and who found it necessary to cure her dyspepsia, to which she had been a martyr for years. He succeeded in this where others had failed, and her explanation was as follows: "The other physicians all told me I must diet, but Dr. Hardaway was the only one to write down what I could eat, when I could eat, and how it should be cooked."

To simply tell a patient to diet himself is usually utterly meaningless to him. He must be informed about every article of diet, and frequently how it should be prepared. This presupposes on the part of the physician knowledge, not only of the nutritive value and digestibility of the various foods, but also a certain knowledge of the art of cooking; for the method of preparing food creates dyspepsia as well as the nature of food. Many physicians have no time to go into such detail. I may inform them that the great London physician, Sir Andrew Clark, takes the trouble to write out these things for his patients. He has no printed dietary. Every patient has peculiarities that modify prescriptions of diet and exercise.

If the patient be an invalid totally incapable of exercise, how important it becomes to enter into every detail of diet!

It matters little to the hod carrier whether his food be indigestible or badly cooked. He is ignorant of the existence of a stomach, earns his bread by the sweat of his brow, and digests pork and cabbage or raw oysters equally well. When physical exercise is indulged in freely the matter of diet is not of much importance. The dyspeptic business man who goes on a shooting trip shortly finds that he may eat what he pleases.

Let me here enter a protest against the mid-day dinner of the American business man. He selects, if it be a good one, the restaurant closest to his place of business, as this saves time and walking. He eats a solid dinner, always hurriedly, for he is in the midst of his business day; he rushes back to his office, crushing the natural inertia following a full meal, and before digestion is fairly commenced his brain is whirling in the excitement of making the almighty dollar. I believe that this custom alone causes an enormous amount of disease. Is it not reasonable to assume that the heavy meal of the day is better eaten when the day's work is done, when one can take time to eat, surrounded, perhaps, by the cheerful influence of wife and children, and afterward quietly sit and give digestion a chance? Every animal, including man, is disposed to mental and physical quietude after a full meal. Mothers often protest against the late dinner for their children, on the plea that they would not sleep or digest well. I have nearly always found this observation based upon imperfect reasoning. Such children do not sleep well after a hearty meal because of enfeebled stomachs, produced by long-continued improper diet. The child which has been reared with strict regard to proper diet sleeps peacefully, even directly after a hearty meal. The English child gets stale bread, the American child is allowed hot bread, to give a single illustration of the different plans pursued.

When we analyze the conditions of longevity from practical experience, we always find two factors, temperance in food and habitual out-door exercise. The lives of Gladstone, Bismarck, Von Moltke, De Lesseps, teach us that work does not kill. But, as each relates, each found time for daily physical exercise. Birmarck, alone, somewhat intemperate at table, was restored to health by a strict dietary.

In saying what I have about the influence of exercise and diet, and other hygienic measures, in curing simple chronic inflammation, and the slight value of drugs, I am not reciting theoretical convictions, but telling actual living experiences, based on observations continued for many years.—*Medical Record.*

BEHAVIOR OF WOOD AND CELLULOSE AT A HIGH TEMPERATURE IN THE PRESENCE OF A LIXIVIUM OF SODA.

IN the first part of his researches upon cellulose and wood, Tauss has shown that distilled water alone is capable of completely dissolving large quantities of ligneous substances.

In a new work he shows how wood and cellulose behave in the presence of alkalies, which, at a high pressure and temperature, must naturally act with much more intensity than distilled water does.

Up to the present, not very much has been known about such action of the alkalies, although soda cellulose has been manufactured for a certain number of years.

We know, too, that Braconnot, on treating wood in this way, obtained the ulmic principles; that Chauchard, in 1856, obtained an English patent for the production of paper and cardboard from wood and plants; that Collier produced cellulose from the vinasse of beets and a two per cent. lixivium of soda; and that Barne and Blondel, in 1862, proposed to treat wood with nitric acid and a solution of soda in order to separate the cellulose from it.

Payen speaks of a process employed at the cellulose factory of Pontcharra, near Grenoble: Disks of wood 5 mm. in thickness are first heated with aqua regia, and then with soda or ammonia in sealed tubes. Payen endeavors to explain the phenomenon as follows:

After the treatment with aqua regia, the cellulose with membraneous form exhibited itself as an almost unattacked residue, while the spongy cellulose, forming the envelope of certain substances, was completely dissolved. In operating thus, these enveloped materials were in the sequel more easily attackable. The alkali served afterward for dissolving the latter. Payen endeavored to demonstrate these facts by elementary analysis.

The first manufactory that employed the lixivium of soda exclusively for the purpose of extracting cellulose from wood was the Manayunk Wood Pulp Works, of Philadelphia. This large establishment exploited an English patent taken out by Burgess & Watt, in 1851. It used a lixivium of caustic soda at 18° deg. B., and kept up the boiling for six hours at a pressure of from 6 to 8 atmospheres (160 to 172 deg. C.)

Krieg, directing the Conmille (England) Works, in 1869, heated wood in fragments with a lixivium of soda at 187·5 deg. C. (11 atmospheres).

In the manufacture of cellulose, the following recommendations must not be forgotten: First, that of Wiegands, who advises us to dry the wood well before the treatment by soda, in order to render it more porous; then that of Gotz and Schulz, who advise us to heat the wood, deprived of bark and cut into small pieces, in a boiler along with milk of lime. The Austrian Society of Aussy, as a preliminary treatment, employs a solution of sulphide of sodium (10 deg. B.), and heats 100 kilogrammes of wood with 30 kilogrammes of the solution for six hours at from five to ten atmospheres.

Thomson, by means of a cold solution (8·26 per cent.) of soda, obtained a substance isomerous with cellulose which he called wood gum. This he obtained from the wood of trees with caducous leaves. From trees having acicular leaves he obtained none at all.

The researches of Koch led to a precise knowledge of the gum and the sugar of wood obtained from the latter. In recent times, Wheeler and Tollens have studied this gum and the sugar of wood (xylose). They manufactured the gum by digesting beech wood shavings in twenty-two per cent. of ammonia. On afterward saturating by an acid, they precipitated some bodies of a dark color of the phlobaphene species. They afterward poured five per cent. of a lixivium of soda upon the shavings and left them to the prevailing temperature. The yellow, alkaline liquid obtained by expression was mixed with an equal volume of 95 deg. alcohol. This latter precipitated the gum that was combined with the soda. This gum was washed with water and with alcohol and water acidulated with hydrochloric acid, and then digested with ether. After desiccation upon sulphuric acid, there remained a white, porous mass. By boiling with sulphuric acid, the gum was converted into sugar (xylose). This gum has for formula, $C^6H^{10}O^5$. It dissolves in two per cent. of soda. It deflects the plane of polarization to the left, and, with phloroglucine and hydrochloric acid, it gives a cherry red color. The formula of wood sugar is $C^5H^{10}O^5$; it melts at 144 deg., deflects the plane of polarization to the right, possesses a strong birotation, and does not furnish lenilic acid, but furfurol, and, with phloroglucine and hydrochloric acid, gives a cherry red color.

As regards the manner in which pure cellulose behaves in the presence of alkalies, we know that a concentrated solution of potash covers it with a film, that a five per cent. lixivium becomes colored of a dark brown, and, finally, that a ten per cent. dissolves as much as fifty per cent. of cellulose, which is precipitated in an amorphous mass if alcohol be added. This substance is not wood gum, but the combination $4C^6H^{10}O^5.NaOH$. Melted with potash, it gives oxalic acid.

Mr. Tauss says that his researches are designed to show, along with its solubility, the facility with which cellulose is attacked by alkalies at different temperatures. In order to study the influence of the degree of concentration, he extended his studies to dilute and concentrated solutions. The duration of each ebullition was three hours. For the production of high pressures, he employed the Muncke digester; but, as the alkaline liquids attacked copper, he took care to line the digester with iron. He allowed the solutions to deposit, and, after clarification, he decanted into a vessel holding a liter. The last portions containing the residuum were diluted with water, and then filtered and washed. The solid residuum was afterward dried on a filter and weighed. Finally, the filtered liquid was diluted to a determinate volume, in most cases to that of a liter.

He now tested the filtered liquid (1) with substances that reduce Fehling's liquor (both hot and cold); (2) with substances precipitable by an equal volume of alcohol; (3) with substances precipitable by an acid; (4) with substances capable of being extracted directly by ether; (5) with substances capable of being extracted by ether after acidulation.

The precipitations by alcohol and acid were, after a careful washing, also determined quantitatively.

The bodies extracted by means of ether ought to give colorations with phloroglucine and hydrochloric acid. The filtered liquid derived from the boiling of cellulose may contain substances that reduce Fehling's liquor likewise. Thus, according to Koch, a combination having the formula $4C^6H^{10}O^5$, NaOH, is precipitable by alcohol.

Tauss employed for his experiments Swedish filtering paper and fine shavings of soft wood (pine), as well as of hard wood (beech).

His researches were now divided as follows:

I. Boiling of cellulose and wood, under ordinary pressure and at an elevated temperature, with a lixivium of soda of the specific gravity of 1·09 (eight per cent. NaOH).

II. Boiling of cellulose and wood, at five atmospheres and a corresponding temperature, with a lixivium of soda of a specific gravity of 1·09.

III. Boiling of cellulose and wood, at ten atmospheres, with a lixivium of a specific gravity of 1·09. A higher pressure was unnecessary, since the decomposition already went too far at ten atmospheres.

IV. Boiling of wood and cellulose, at the ordinary pressure and at an elevated temperature, with a lixivium of soda of the specific gravity of 1·162 (fourteen per cent. NaOH).

V. Boiling of cellulose and wood, at a pressure of five atmospheres, with a lixivium of soda of the specific gravity of 1·162.

VI. Boiling of cellulose, at the ordinary pressure and at a high temperature, with a lixivium of the specific gravity of 1·043 (three per cent. NaOH).

VII. Boiling of cellulose and wood, at five atmospheres and at a corresponding temperature, with a lixivium of the specific gravity of 1·043.

VIII. Boiling of cellulose and wood, at a pressure of ten atmospheres and at a corresponding temperature, with a lixivium of the specific gravity of 1·043.

The results that he obtained may be summed up as follows:

Behavior of Cellulose.—The dissolving power of cellulose in alkaline liquids increases with the temperature and pressure, although, for all that, the concentration of the lixivium exerts a greater influence.

Moreover, a long ebullition can replace in part only a greater concentration. With a lixivium of soda of a specific gravity of 1·162 (fourteen per cent. NaOH), three-fourths of the cellulose were already dissolved at a pressure of five atmospheres, and, with a lixivium of a specific gravity of 1·09, a half only. The solutions contain substances so much the more precipitable by alcohol (according to Koch, $4C^6H^{10}O^5$, NaOH) in proportion as the pressure is higher and the lixivium more concentrated. The acids precipitate brown bodies, the quantity of which increases along with the temperature and pressure. Fehling's liquor is reduced by no solutions. The ethereal extract is always weak and gives no coloration with phloroglucine and hydrochloric acid.

Behavior of Soft Wood (*Pine*).—Soft wood is easily attacked by a dilute solution of soda, at a high pressure and a high temperature. The dissolving power of the lixivium increases here also with the increase of pressure, but still more so with the concentration. A greater length of boiling is capable of replacing a greater concentration only in part.

With a lixivium of a specific gravity of 1·162, at five atmospheres, the wood is almost completely dissolved; half of it is even dissolved with a lixivium of the specific gravity of 1·043.

If we employ a lixivium of 1·162, at a high pressure, alcohol precipitates substances that may be easily inverted by means of dilute sulphuric acid, and such inverted substances reduce Fehling's liquor.

The acids precipitate bodies of a brown color and of the species of humus. Fehling's liquor gives no reaction. If we acidulate and afterward recover by ether, there remains, after the evaporation of the latter, yellowish brown bodies which, in certain cases, become colored red by phloroglucine and hydrochloric acid.

Behavior of Hard Wood (*Beech*).—Hard wood is strongly attacked by dilute lixivia. Long boiling does not entirely replace a greater concentration. Almost all the wood is dissolved with a lixivium of a specific gravity of 1·162 at five atmospheres. A lixivium of a specific gravity of 1·043 dissolves more than half of it.

At the ordinary pressure, alcohol precipitates substances which separate of themselves at a high pressure in a concentrated lixivium. The acids likewise precipitate matters, of which the quantity is so much the greater in proportion as the pressure has been higher and the lixivium more concentrated. Fehling's liquor is not reduced. If, after acidulation, we recover by ether, we obtain, through evaporation, a yellowish residuum, which, in some rare cases, gives red colorations with phloroglucine and hydrochloric acid.

In practice, the use of high pressures leads really to great losses. The quantity of cellulose obtained out of 100 parts of wood amounts in most cases to but 30 or 35 parts.

Sugar and bodies like sugar are not found in the alkaline liquors. They are met with only in the wood gum, especially in hard woods. In return, substances precipitable by the acids are in almost all of the solutions. The extracts obtained through ether are constantly weak. The coloring reactions with phloroglucine and hydrochloric acid are too isolated to furnish a sure confirmation. The tints of the colored reactions are red, while the aqueous extracts of wood give blue violet and red violet.—*Moniteur Scientifique.*

ON THE ACTION OF CERTAIN LIQUIDS ON ALUMINUM.

By Prof. GEORGE LUNGE, Ph.D.

SOME months ago a paper was published in a German pharmaceutical journal by Lubbert & Roscher on the behavior of aluminum toward a number of liquids with which that metal might come into contact when made into canteens, cooking vessels, surgical instruments, etc. The conclusions reached by those two observers would be detrimental to the application of aluminum for any use in which it may come into contact with liquids intended to pass into the human body. Before such a conclusion, momentous as it would be for the extension of the use of aluminum in many directions, can be accepted as valid it ought to be verified by other observers, especially as neither of the above named gentlemen is a chemist in the proper sense, one being a medical man and the other a pharmacist fresh from his studies.

The method employed by Lubbert & Roscher is anything but trustworthy. In the first instance they did not make any quantitative estimations, but confined themselves to qualitative observations, which may be very deceptive, as some of the substances employed were probably not free from alumina; secondly, they worked exclusively with aluminum foil, which is well known to be much less resisting to chemical action than compact sheet aluminum.

This induced me to take the matter in hand, in conjunction with my demonstrator, Mr. Ernst Schmid, and I will now give a short account of our results:

Our experiments were all made with commercial rolled sheet aluminum, 1 mm. thick, from the Neuhausen works, of the following composition: 0·44 per cent. combined silicon, 0·11 per cent. crystallized silicon, 0·25 per cent. iron; traces of copper; 99·20 per cent. aluminum (by difference). The sheet was cut up into strips of such a size that they could be conveniently introduced into the flasks serving for our experiments. Each strip was freed from sharp edges by a file and was thoroughly cleaned in order to lay bare a real metallic surface and remove the excessively compact surface produced by the rolling process. They were for this purpose treated, first with concentrated solution of caustic soda, then with water, then with dilute sulphuric acid, again with water, scrubbed with a brush and distilled water, rinsed with alcohol and dried in an oven. Three such strips were accurately weighed, hung by means of small holes, upon a glass hook, in such manner as not to touch one another, and introduced into the flasks containing the liquids to be tested. Each flask held about 400 c. c. of liquid and was closed by a cork through which passed the stem of the glass hook. After leaving the whole for six days at the ordinary temperature of the room, the strips were taken out, rinsed with distilled water, freed from any adhering alumina, by means of a soft brush, rinsed with alcohol, dried and weighed. The loss of weight was referred to the aggregate surface of the three strips (about 190 square centimeters) and is in the following table reduced to 100 square centimeters. Each liquid was tested at least twice in order to guard against accidental mistake. In a few cases, where the

nature of the liquids presented no special difficulties, the alumina was, moreover, determined gravimetrically in the liquid after the experiments with results closely approximating those found by ascertaining the loss of weight of the aluminum. The following table gives the results of our experiments:

Liquids experimented upon.	Loss in weight.			
	A mg.	B mg.	Average mg.	Reduced to a surface of 100 sq. ct. mg.
Ordinary claret	4·1	3·3	3·7	2·84
" hock	4·0	4·5	4·3	3·27
Brandy	1·6	1·2	1·4	1·08
Pure 50 per cent. alcohol	0·8	0·8	0·8	0·61
5 per cent. solution of tartaric acid	1·9	2·4	2·2	1·69
1 per cent. solution of tartaric acid	3·6	3·1	3·4	2·58
5 per cent. acetic acid	4·3	5·7	5·0	3·85
1 per cent. " "	6·2	5·2	5·7	4·38
5 per cent. solution of citric acid	2·8	2·8	2·8	2·15
1 per cent. solution of citric acid	2·3	2·6	2·5	1·90
5 per cent lactic acid	6·1	6·3	6·2	4·77
5 per cent. butyric acid	1·7	1·7	1·7	1·31
Coffee	0·6	0	0·7	0·50
Tea	0	0	0	0
Beer	0	0·7	0	0
4 per cent. boric acid solution	2·3	2·3	2·3	1·77
5 per cent. carbolic acid	0·1	0·5	0·3	0·23
1 per cent " "	0·8	0·5	0·7	0·49
½ per cent. salicylic acid	7·3	9·2	8·3	6·35

In very few of the cases was any action outwardly visible. In the case of brandy and alcohol, where the quantitative action was extremely slight, the surface of the aluminum showed a few fungus-like excrescences, probably formed by alumina, and caused by accidental flaws in the sheet. Lubbert & Roscher found that alcohol, ether and all similar liquids had no action at all on aluminum foils, so that the observation made by us would appear to be due to an accidental cause. Only in the last case, that of a solution of salicylic acid, did the aluminum lose its bright surface and become dull.

From our experiments the following conclusions may be drawn: The action of coffee, tea (both of which had been poured in hot), and beer is zero or practically so; that of brandy is also extremely slight; the action of acids and acid liquid (wine, sour milk, fruit juices, etc.) is more pronounced, but even in this case far too slight to cause any alarm whatever. Taking the worst case found, that of acetic acid, we find a maximum attack of less than 5 milligrammes per 100 square centimeters in 6 days. Now a canteen holding a liter (or nearly a quart) has an inner surface of about 600 square centimeters and an aluminum weight of about 200 grammes. Such a canteen would in the very worst case lose 5 milligrammes in a day, even if it were always full, or 1 gramme in 200 days, and only in 55 years would it be reduced to half its weight. This is certainly too trifling a work to be practically considered. Nor is there the slightest danger of any injurious action upon the human body by such traces of aluminum compounds, seeing that our food contains very much more of these. Moreover, aluminum compounds are not poisons in the ordinary sense, to be compared to compounds of arsenics, mercury, lead, copper compounds, etc.; they cannot act injuriously unless quantities a hundred times larger than those we have found were regularly entering into the human stomach.

The final conclusion must, therefore, be this: That aluminum may, without any fear, be employed for canteens or any other vessels serving for holding articles of food, at least at the ordinary temperature.—*Engineering and Mining Journal.*

REMEDY FOR BUMPING.

E. PIESZEZEK, in the *Chemische Zeitung*, gives a description of a simple device made use of by him for the prevention of the phenomenon known as "bumping" in boiling liquids. It consists in placing a glass tube about 5 to 8 cem. in length, and 5 to 10 minims in width (the exact dimensions depending upon the bulk of the liquid to be boiled), and closed at the upper end, resting upon the side of the flask or other vessel to be heated, so that it stands nearly vertical, with its open, sharp-edged end pointing downward.

Boiling goes on quietly when once started, the bubbles making their appearance at the lower end of the tube. On cooling, the liquid rises in the tube, which must therefore be raised and allowed to again become full of air before beginning the boiling again. The device is said to be efficient even for liquids containing heavy precipitates such as barium sulphate and lead sulphate, and is also recommended for the Reichart-Volny process.

A NEW PROCESS FOR THE RECOVERY OF AMMONIA DURING GALVANIZING.

A PROCESS of great interest to galvanizers, and which must sooner or later affect the producers of sal-ammoniac and muriate of ammonia, has just received a satisfactory practical trial at the works of the Wolverhampton Galvanizing Co., at Wolverhampton.

It has been known for years that only a small proportion of the muriate of ammonia employed in the foregoing industry is practically utilized, it being imagined that the remainder was lost by volatilization. It has remained, however, for Messrs. Saunders & Saunders, the manufacturing chemists of Cleckheaton, Yorkshire, to discover that only the smaller portion of the ammonium chloride is, strictly speaking, volatilized, the major portion being evolved as free ammonia.

Upon the foregoing discovery they have founded a process for the recovery of the ammonia evolved during the process of galvanizing, which they have patented. Briefly described the process is as follows:

The galvanizing pots containing the molten spelter, and on the surface of which muriate of ammonia is occasionally sprinkled, are surmounted by hoods, and these are connected with a tall scrubber, down which an acid solution is made to flow. A Blackman air propeller is placed at the foot of the tower, which causes the fumes from the pot to pass into the hood, and from thence into the tower; during the passage of these gases through the tower they become absorbed and dissolved. The acid solution is pumped over and over again through the tower, until it is rendered nearly neutral to test papers, when it is taken away and evaporated, fresh acid being employed in the tower. Roughly 60 per cent. of the ammonia is in the free state, the remainder being volatilized muriate.

As we saw the process at work it was simplicity itself; a sharp lad could manage the whole plant for an installation of any magnitude, and the heap of recovered muriate of snowy whiteness testified to the fact that an immense saving must attend the use of the process.

In brief, this process collects the ammonia hitherto lost by the galvanizer, and returns it to him ready to be used again. The value of the restored product (with a recovery of only 50 per cent.) amounts to upward of £20,000, the whole of which has up to now been totally lost to the trade.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.